# NATURE

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## MOVEMENTS OF BOOKS ACROSS NATIONAL BOUNDARIES

EARLY last year Sir Stanley Unwin reviewed, in a pamphlet entitled "How Governments Treat Books", some of the obstacles which taxation policy offers to day to the free flow of books from one country to another. Sir Stanley quoted his examples from a summary of the regulations which affect the export of British books, prepared by the Publishers Association of Great Britain and covering some fifty-five countries. With the exception of those for the United States, which still discriminate against the British Commonwealth, most of these regulations apply to books from all countries. Besides taxes and customs duties, forms and formalities, as well as currency difficulties, also constitute serious obstructions to the dissemination of knowledge by the circulation of books.

Sir Stanley in this pamphlet, rightly emphasizing the value of books for the transmission not merely of knowledge but also of thought, pointed out that post-war governments are treating with scant respect this unique and priceless instrument for giving continuity and permanence to the free expression of thought. In many otherwise civilized countries, there is an increasing tendency to treat books as if they were merely an ordinary commodity of commerce, without cultural value or importance. The fundamental principle that the one thing no country can afford to hamper, limit or tax is knowledge no longer receives the respect that it enjoyed a century ago; and in the climate of opinion that is engendered by security measures, once they escape beyond the limits that the national interest requires in such matters as atomic energy, the progress of knowledge is bound to slow down.

Sir Stanley maintained in this pamphlet that the surest way of remedying the situation is ruthless publicity and exposure of all obstacles to the obstruction of the circulation of books. He instanced the campaign in Great Britain which in 1940 led promptly to the withdrawal of the Chancellor of the Exchequer's proposal to levy purchase tax on books as an example of the fact that no government finds it easy to defend the taxation or obstruction of knowledge when once it is publicly challenged, or likes to be held up to ridicule over its treatment of books as so many pieces of merchandise. Books, however, are not the only media for the exchange of knowledge, thought and culture, and the United Nations Educational, Scientific and Cultural Organization has done well to prepare and publish "Trade Barriers to Knowledge" (Paris: Unesco; London: H.M. Stationery Office, 1941. 6*s*.).

In this are set forth the tariff and trade regulations affecting the movement of educational, scientific and cultural materials from one country to another. This covers some forty-three countries and embraces regulations affecting not only books, periodicals, newspapers, etc., but also works of art, films, scientific instruments and apparatus, and materials specially for the blind. The book was compiled primarily as a practical handbook for publishing houses, film

libraries, scientific laboratories and all organizations, as well as individuals, interested in obtaining such materials from abroad, or in sending them to other countries.

This publication is undoubtedly a useful step towards overcoming the formidable obstacle to the international circulation of such material which is presented by the complexity and variety of trade regulations in different countries and the inaccessibility of information concerning them. Confronted with this maze of restrictions, many organizations and individuals are discouraged from embarking on international exchanges of such materials, or even their sale in countries abroad. Even more important, however, is the service which the book should render to the efforts now being made in many countries for the reduction and progressive elimination of obstacles to the international circulation of educational, scientific and cultural material. The facts it records provide material for a sustained attack on many of the absurdities of the present situation; and an admirable introductory chapter, in which the development of those restrictions is reviewed and the attempts already made by Unesco to deal with the situation are explained, should assist in putting the facts in a true perspective.

It is indeed no pleasant picture that is presented by this manual, nor does the United Kingdom make a good showing. No consolation can be found in the reflexion that while modern technology has made possible the transmission of books, periodicals, newspapers, and other educational material across frontiers on an unprecedented scale, the present restrictions to such a flow have developed fortuitously rather than by design. Revenue derived from duties on such materials is relatively small, and rarely is any serious danger of competition with domestic industry involved. Frequently the regulation or restriction is trivial in the extreme, as derisory as it is irritating: it is the official outlook or attitude of mind revealed in the regulation that is so depressing.

The question of 'book tallies' in itself is trivial; but the official obtuseness which subjected them to purchase tax is an example of the lack of imagination which is responsible for many of the regulations, and which should be attacked unceasingly by all who are convinced that the restrictions placed upon the free flow of knowledge can and should be lifted. While such lack of imagination persists, there will be continual danger, for example, that legitimate barriers on the ground of military secrecy to the exchange of knowledge in certain fields of physics will be converted into barriers to the exchange of general knowledge. Muddled thinking rather than illiberal intentions are likewise responsible for allowing paper and books and paintings and other materials for conveying knowledge to become entangled in the general web of tariffs and currency regulations. While it is true that in Great Britain there is no purchase tax on books, even learned scientific and technical books are subject to a quota system, of 200 per cent of the value of pre war imports. Rising prices, not to mention the expansion of scientific and industrial research and the doubling of the university population in science and technology, make nonsense of any such figure.

What is required over the whole field is the play of a critical and imaginative intelligence bringing the regulations or restrictions into relation with realities, as is so often vividly illustrated in the minutes recorded in Mr. Winston Churchill's war memoirs, and sweeping away the waste of man-power on the issue or refusal of licences that serve no purpose. Full use should be made of the Unesco book to secure that action and to challenge the dubious restrictions here revealed. Unesco itself has already sought to reduce trade barriers to knowledge by sponsoring two international agreements which would raise the standard of dispensation. One, the Agreement for Facilitating the International Circulation of Visual and Auditory Materials of an Educational, Scientific and Cultural Character, had, by the beginning of 1951, been signed by eighteen countries, but only four (Canada, Norway, Pakistan and Yugoslavia) of ten ratifications required to bring this convention into force had been forthcoming. The Agreement on the Importation of Educational, Scientific and Cultural Materials, which would grant duty-free entry to publications, works of art, visual and auditory materials, scientific materials and articles for the blind, consigned to approved institutions, has been signed by seventeen countries, but also awaits the necessary ten ratifications to bring it into force. Besides in this way attempting to reduce the barriers to the international circulation of such material, Unesco is also endeavouring to help countries to meet their needs in this field, despite shortages of foreign currency, by encouraging exchanges of information on needs and resources, promoting trade agreements and stimulating domestic production. Here Unesco is working with the regional economic commissions of the United Nations, and some indication of its activities is given in the introductory section of the book. But its prime importance is the further weapon it affords educated opinion, in every country, for pressing even more insistently for the sweeping away of pedantic obstructions to the exchange of educational, cultural and scientific material of all kinds, and insisting that only those regulations are retained for which a reasoned case, acceptable to responsible and informed opinion, can be presented.

## NATURAL AND SYNTHETIC DRUGS

### Medicinal Chemistry

Chemistry, Biochemistry, Therapeutic and Pharmacological Action of Natural and Synthetic Drugs. By Prof. Alfred Burger. Vol. 1. Pp. xviii+577. (New York and London: Interscience Publishers, Inc., 1951.) 10 dollars.

TWO of the most outstanding characteristics of twentieth-century organic chemistry have been the amount of attention devoted to biologically active compounds, both natural and synthetic, and the striking successes which have attended investigations in these fields. It is not surprising, therefore, that

many books have been written to survey and co-ordinate the results of these researches. There have been monographs on chemotherapy, antibiotics, vitamins, hormones, sulphonamide drugs, and similar topics, as well as on more restricted subjects within these fields, and also more general works covering, for example, the whole range of synthetic drugs. Prof. Burger's book is the first of two volumes in which he plans to give a comprehensive account of all classes of natural and synthetic drugs. The treatment is not confined to their chemistry, but includes also a description of their pharmacology, with some discussion of the mechanism of their action and of the relationships which have been found between chemical structure and biological activity. This is a commendable if ambitious project. Prof. Burger has himself made many important contributions in studies on synthetic drugs. But he could scarcely be expected to have first-hand knowledge of all the subjects on which he has written in the present volume. The book is inevitably somewhat of a compilation, and the treatment rather superficial. On the whole, though, it is a well-arranged compilation which is not unduly afflicted with the shortcomings often found in such works, and is a valuable and interesting work of reference. There is sufficient bibliography to direct the reader's attention to more authoritative and more extensive surveys of individual topics.

The compounds dealt with are classified according to their pharmacological effects, and the grouping together in a single chapter of all the drugs of various chemical types which exert a given pharmacological action is a very valuable feature. Volume 1 is largely concerned with pharmacodynamic drugs, whereas Volume 2 will deal mainly with chemotherapeutic agents which are used for combating diseases due to bacteria and other parasitical organisms. The volume under review includes accounts of general and local anæsthetics, hypnotics, anticonvulsant drugs, analgesics, cardiovascular drugs, autonomic drugs and antihistamine compounds. In addition, there are a few chapters on unrelated groups such as the vitamins and diagnostic agents. The book is attractively produced and the structural formulæ are printed in a particularly clear and pleasing manner. An unusual but useful feature is that the number of the chapter is given on all the even-numbered pages. The formulæ are numbered in a novel manner which might well be adopted by other authors. To each formula is attached the number of the chapter, in Roman numerals, followed by a figure in Arabic numerals representing the number within the chapter. This facilitates cross-reference, provides a unique label for each of the many formulæ throughout the book, and at the same time avoids the cumbersome and sometimes difficultly decipherable expressions resulting from the use of Roman numerals for a long series of formulæ.

Much confusion exists in naming drugs which are put on the market for clinical use. Half a dozen different names may be assigned by different manufacturers to the same product. Prof. Burger has attempted to rationalize his nomenclature. The now usual practice of treating trade names as proper nouns is followed, and widespread use is also made of the alternative names assigned by the Council of the American Medical Association. The trade names used are, very naturally, mainly American, and this may sometimes mislead British readers. For example, in the section devoted to the synthetic analgesic, Demerol, there is no reference to the British name of pethidine, or even to the name (Dolantin) given by the German discoverers of this drug. Incidentally, perusal of the chapter on analgesics shows the very wide range of structures associated with such action. In the preceding chapter attention is directed to the close structural resemblances between some hypnotics, anticonvulsants, analgesics, spasmolytics and antihistaminics. Those who have a prejudice against the use of drugs will perhaps be interested in the estimate that the American people consume about five to six million kilograms of caffeine per year in coffee alone.

The treatment of the chemistry of the drugs is very sketchy. Although structural formulæ appear in great profusion, only in very few cases has any attempt been made to show how they were established. Synthetic procedures are sometimes outlined; but this appears to be restricted to actual manufacturing processes. One wonders whether this is a good principle. In a book of this sort it seems scarcely necessary to devote a whole page to a series of formulæ illustrating the synthetic production of theophylline.

It is easy to find imperfections and occasional inaccuracies in a book covering such a wide range of subjects. The statement that "Paracelsus was a superficial quack" invites rejoinder. The first lecturer in chemistry in the University of Glasgow, William Cullen, was better known as a distinguished physician; but it is a little odd to find him described as "the Scotch surgeon". The early American work on anæsthetics is faithfully reported; but there is no mention of the introduction of chloroform by Simpson, of Edinburgh. The preparation of androsterone from cholesterol is wrongly attributed to Butenandt, the final elucidation of the structure of strychnine is attributed to Woodward, and there are similar historical distortions in regard to the structure of colchicine and of the cardiac glycosides. There is no warrant for, neither is there any meaning in, the statement that the carcinogenic properties of 9-hydroxymethylbenzpyrenes are more pronounced than those of corresponding methyl derivatives.

Taken as a whole, however, this book is an excellent piece of work and will be extensively used by those interested in synthetic drugs.

J. W. Cook

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## HISTORICAL APPROACH TO BACTERIAL CYTOLOGY

### Elements of Bacterial Cytology

By Prof. Georges Knaysi. Second edition. Pp. xix+375. (Ithaca, N.Y.: Comstock Publishing Co., Inc., 1951.) 5 dollars.

THIS book has been considerably expanded since the first edition; but it is apparent that Prof. Knaysi's fundamental views upon the subject have been little affected by the greatly increased body of evidence which has accumulated in recent years since the resurgence of interest which he has done so much to promote. Only the briefest recognition is accorded to the acid-hydrolysis techniques by which the bacterial nucleus was, in fact, first convincingly demonstrated. He does not appear to have grasped the significance of the findings which have been made by this means, but apparently believes that the dumb-bell shape of the bacterial chromosome indicates transverse fission at the point of constriction.

The extraordinarily low standard of the photomicrographs by which the acid-Giemsa stain is illustrated, in contrast to the general excellence of the plates with which the book is lavishly provided, may explain his distaste for the method.

The work of the early bacterial cytologists is well reviewed, and many of their original drawings are reproduced. The value of this historical research should not be underestimated; but it would be even greater if it were combined with an equally full account of studies performed since the early nineteen-thirties. There is, for example, only a single, brief reference to the work of Robinow, and the entire chapters upon the cytology of Actinomycetes and Myxobacteria make none at all to the exceedingly important papers of Klieneberger-Nobel, only one of which is quoted in the whole book. Phenomena now widely accepted and repeatedly confirmed, such as the *L*-form mode of reproduction, multicellularity of the higher bacteria, variety of types of cell-division, and the autogamous processes associated with sporulation, are either treated with exaggerated reserve or totally ignored.

The format of the book is very attractive and the illustrations are particularly good. Electron microscopists will find much to interest them in the numerous micrographs which are included.

K. A. Bisset

## THE HOME LIFE OF AN ASTRONOMER

### Ninth Astronomer Royal

The Life of Frank Watson Dyson. By Margaret Wilson. (Published for the Dyson Family.) Pp. xvi+294+14 plates. (Cambridge: W. Heffer and Sons, Ltd., 1951.) 25*s*. net.

THE biography of Sir Frank Dyson, ninth Astronomer Royal, by his daughter, Mrs. Wilson, gives a vivid account of the home background to his professional life. To those many who knew him personally and enjoyed his friendly hospitality in Greenwich or Edinburgh, this book will bring back happy memories of Dyson himself, his gracious wife and his cheerful family. But it must be admitted that the book would have gained considerably in value if it had included a full account of his scientific career and work written by an astronomical colleague. A clear picture of Dyson the man, as seen from the family circle, is given: Dyson the astronomer, however, is seen mainly from the same limited point of view, the account being supplemented by too little scientific appreciation. The result is a lack of balance in the picture.

This being said, we may turn with gratitude to what Mrs. Wilson has done in relating with such obvious enjoyment the story of the Dyson family. Like so many scientific men both in Great Britain and in the United States, Dyson was a son of the manse. His father was a prominent Baptist minister, and it was natural that Dyson as a young Cambridge graduate should follow his friend, T. R. Glover, as president of the Cambridge University Nonconformist Union. Typical of interests maintained throughout his life were the two papers he read to that body on "Robert Browning" and "The London Poor". But we must not omit, in speaking of his early days, to refer to the influence of his school. Dyson was fortunate in his headmaster and schoolfellows: Bradford Grammar School under Keeling produced a notable set of brilliant boys who made a mark for themselves later in life—it must suffice to mention here Benjamin Gott, William Rothenstein and John Coates. In Cambridge Dyson graduated as second Wrangler (the Senior Wrangler of his year, Sir Gilbert Walker, still happily survives); he was first Smith's Prizeman the year after Sampson, whom he also followed a year later as Isaac Newton Student. Years later, Sampson was to follow Dyson as Astronomer Royal for Scotland.

Dyson's father, possibly influenced by the friendship of Dawes, a well-known observer of double stars, had foretold at his birth that he would become Astronomer Royal. The opportunity came when Christie invited him in 1894 to succeed Turner as chief assistant at the Royal Observatory, Greenwich. Dyson accepted with alacrity, and from that day his career was marked out clearly for him. His observational work at Greenwich was varied with solar eclipse expeditions to Oran, Pulo Aoer Gadang and Sfax, at all of which he was favoured with fine weather: his luck in this respect never deserted him, and he was successful in observing six total eclipses of the sun in six attempts.

In 1905 came the move to Edinburgh, where Dyson's experience as Astronomer Royal for Scotland prepared the way for a return to Greenwich five years later as Astronomer Royal. Here he proved to be an administrator of sound judgment and keen practical sense, a greatly loved chief. One of his most striking decisions was taken during the dark days of the spring of 1918: that was to back the preparations for the Einstein eclipse of 1919. It is in the account of this eclipse that we find this book at fault on the scientific side—Einstein's special theory of relativity being ascribed to Newton.

One feature of Dyson's great influence on the astronomical world of his day was his participation in the international side of astronomy. Both as a ready and genial host to foreign astronomers visiting England and as one who co-operated fully with them in congresses, he formed an important link in the network of joint schemes which covers the astronomical world. It was only natural that in due course he should become president of the International Astronomical Union. This was one of many richly deserved honours that came his way. Perhaps none pleased him more than the honorary degree of Sc.D. conferred upon him by the University of Cambridge. With the final passage in the speech of his old friend, T. R. Glover, the Public Orator, we may fitly close this review—*Litteris, amicitiis, scientiis humanitate—sic itur ad astra.*

F. J. M. Stratton

## TROPICAL ANIMAL NUTRITION

### The Feeding of Farm Animals in India

By Dr. P. E. Lander. (Animal Husbandry Manuals.) Pp. xii+492+lii+46 plates. (Calcutta, Bombay, Madras and London: Macmillan and Co., Ltd., 1949.) 14 rupees; 25*s*. net.

THE temperate zones of the world are well supplied with text-books which give information obtained from experiments published in many different and often inaccessible journals and reports. If progress is to be made in agriculturally backward areas in the tropics, similar books are essential, for the soils, crops and livestock are so different in the

tropics that text-books written for temperate zones are of little real use and in some cases are often misleading.

This book, the first of its kind on animal nutrition in India, compiled from experimental results which have been obtained there and by one who has spent a life-time working on the subject, should be most useful to those who are doing advisory work on animal production not only in India but also throughout the tropics. The tables of chemical composition and digestibility, mineral and vitamin content of Indian feeding-stuffs will be invaluable for the rationing of animals in tropical countries, for until this book appeared they were to be found only in inaccessible publications and reports. These tables will do for the tropics what the tables of Kellner, Armsby and others have done for temperate climates. In general, the book follows the traditional lines of those on animal nutrition, but with special reference to Indian conditions, and includes sections on the feeding of buffaloes and camels. A chapter on some harmful foods and famine fodders supplies useful information rarely found in nutrition books written for temperate climates.

Perhaps the most important respect in which the book differs from those written for temperate areas is that it starts with the soil and deals with its deterioration and erosion from overgrazing, an aspect of animal nutrition which is of special importance in the tropics. As the author states, the ultimate solution of the problem of feeding animals in India lies in the restoration of the proper equilibrium between the soil and the human and cattle population.

JOHN HAMMOND

## BIRDS OF A LOW RAINFALL REGION

**A Handbook of the Birds of Western Australia (with the exception of the Kimberley Division)** By D. L. Serventy and H. M. Whittell. Second edition. Pp. viii+384. (Perth: Paterson Brokensha Pty., Ltd., 1951.) n.p.

AUSTRALIA, scarcely less than Great Britain, has of recent years been flooded with 'Nature books' of dubious accuracy and of poor quality. These have been hastily put together in order to exploit the growing desire of the public for information about animals, particularly birds.

The present volume is a refreshing departure from the general run of ornithological literature. It is the result of much painstaking scholarship, and it contains information that will interest any biologist who is concerned with the effects of landscape aridity on form, of environmental change on distribution, or the influence of irregular and scanty rainfall on the breeding seasons of animals. It is, then, far more than a mere handbook of the fauna of a single restricted area within political boundaries.

Certain parts of the book are of especial interest in that they throw further doubt on the validity of the day-length hypothesis in the regulation of avian breeding seasons. This notion has gained almost universal acceptance since Rowan's epochal demonstration, about twenty-five years ago, that the reproductive mechanism of vertebrates can be stimulated by increased lighting. There can, of course, be no question that the hypophysis can be indirectly influenced and gonad modification induced in many species by artificial photostimulation; but the importance of day-length as an ultimate, or even as an initiating factor, in the timing of avian breeding seasons under natural conditions has been seriously questioned by recent work in Britain on British and Australian species. Serventy and Whittell point out in the volume under review that in Western Australia light increases in duration from June until December; but, in the southern parts of the country, many species ovulate from mid-April onwards. In the north-west, breeding occurs mostly in the winter, while in the south-west most birds ovulate during the spring months when light is increasing. In each region there is a very pretty correlation between sexual activity and rainfall, and as a consequence, the young are launched from region to region at times most propitious for their survival. In one area where spring ovulation is normal, a heavy and unseasonal deluge was followed by widespread autumn reproduction. A hundred miles away where the rains did not penetrate, breeding did not occur until the following spring. This kind of information supports the concept that after the post-nuptial period of gonad metamorphosis (which varies in duration from species to species) many birds are ready to undergo reproductive activity immediately there occurs in the environment the combination of external stimuli to which they are hereditarily attuned to respond. Breeding can occur quite irrespective of changes in day-length. Serventy and Whittell have further information that suggests the operation of an internal rhythm among sea-birds. The silver gull (*Larus novæ-hollandiæ*), for example, has a winter and a spring breeding population on the same small coastal island.

The present "Handbook" contains a great amount of detail that is chiefly important to local naturalists, including a most excellent history of Western Australian ornithology dating from the seventeenth century explorers such as van Hillegom, de Vlamingh (who discovered that a black swan was not a *rara avis* after all) and the remarkable English buccaneer, William Dampier. It is to be hoped that subsequent editions may include the birds of the remote Kimberley region with its 'incubator bird' (*Megapodius*), fruit-pigeons, pittas and other forms of tropical origin and affinity. In fact, one cannot think of two men better qualified to write a much-needed modern handbook covering the birds of the entire continent of Australia.

A. J. MARSHALL

## SIX-FIGURE MATHEMATICAL TABLES

**Chambers's Shorter Six-Figure Mathematical Tables** By Dr. L. J. Comrie. Pp. xxvi+388. (Edinburgh and London: W. and R. Chambers, Ltd., 1950.) 12*s.* 6*d.* net.

WHEN accuracy in simple numerical calculations greater than that attainable by the use of the common four- or five-figure tables has been desired, it has been usual to resort to Chambers's seven-figure tables, although they are restricted to common logarithms and the trigonometrical functions. The question of a revised edition of the latter tables was referred to Dr. L. J. Comrie, and the substance of his recommendations was that a wider range of ele-

mentary functions should be included and that they should be on a six- and not a seven-figure basis. The main reason for the latter recommendation was that it made linear interpolation possible within a reasonable compass, and it was defended on the grounds that, apart from certain specialist needs already adequately catered for, ordinary scientific and technological calculations would need higher accuracy only very rarely indeed. The result was "Chambers's Six-Figure Mathematical Tables", in two volumes. The volume now under review is essentially an abridged version of these, containing a selection of the more useful tables. Many users will find this collection adequate for their needs, and there is obvious convenience in a single volume, if its contents do indeed suffice.

Most of the pages have been taken direct from the two-volume edition, but some have been reset at a wider interval. As will be seen from a summary of the contents which is given below, the range of elementary functions is quite well covered, which was certainly not the case with the old 'Chambers'. Much more emphasis has been laid on natural than on logarithmic values, since the former are much more frequently required in these days of mechanical computation.

The main tables give common logarithms, logarithmic and natural trigonometric functions (with argument in degrees, minutes, and seconds), circular functions (argument in radians), exponential and hyperbolic functions, natural logarithms, inverse circular and hyperbolic functions, powers, roots, reciprocals, factors and factorials. Pages of formulæ relating to the functions tabulated, lists of series and integrals, formulæ and tables of coefficients for interpolation and for numerical differentiation and integration, and sundry conversion tables, are included, along with copious worked examples showing how the tables may be used most efficiently.

The tables are planned so that, in general, linear interpolation gives the greatest accuracy attainable from them, and in the main tables the appropriate proportional parts are provided at every opening. In the few ranges where the second difference correction cannot be neglected, the user's attention is directed to this fact by the printing of the first differences in italics. Bessel's formula for applying the necessary corrections is advocated, and tables of the values of the coefficients are given. Other cases where linear interpolation becomes difficult are met by auxiliary functions (for example, $s(x) = \log x - \log \sin x$ for small $x$). For slowly varying functions (and this includes most of the auxiliary functions just mentioned), so-called 'critical' tables are provided.

Apart from the refinements of typography and lay-out which one associates with the name of Dr. Comrie, one cannot fail to be impressed by the evidence of the thought given and the care taken to provide the user with the maximum of information in the minimum of space, and the maximum accuracy with the minimum labour. Almost every page contains some ingenious device—many invented by Dr. Comrie himself—directed to one or other of these ends. The book is well produced, and is bound so that it lies flat at any opening, a great convenience in use. It represents remarkable value for money.

This was the last of Dr. Comrie's projects which he was able to see completed. By it alone one can measure both his greatness as a maker of tables and the loss we have sustained by his passing.

W. G. Bickley

# HUMANITY AND THE HELM

## The Human Use of Human Beings

Cybernetics and Society. By Prof. Norbert Wiener. Pp. xi+241. (London: Eyre and Spottiswoode (Publishers), Ltd., 1950.) 18*s*. net.

SOME two years ago, Prof. Norbert Wiener published a book on cybernetics, in which he developed the subject mathematically, mainly with the object of clarifying certain researches in communication-engineering, to which he has made notable contributions.

He now follows this up with a volume more specifically aimed at the layman, and naturally hopes that it will keep its bearing fair and square upon the target (however erratic that target's course may be), as all good cybernetical devices should.

The sub-title "Cybernetics and Society" is appropriate, although we are told much more about the latter than about the former. Steering committees have become accepted in twentieth-century affairs: cybernetics and the whole armoury of calculating machines are means (theoretical and existential) of performing many functions for mankind from without rather than from within. The perils of all this are manifest, and need little emphasis.

Once the outlook is grasped, the course of this book follows almost automatically: entropy, language, semantics, communications, industrial revolutions (two), and the voices of rigidity. That Prof. Wiener has a profound respect for the human being is of the essence of these pages, and on that score alone his work commands both respect and gratitude. What, however, is less obvious—and sometimes a little irritating—is whether or not he is referring specifically to his own country (the United States) or whether his edicts are meant to apply universally. There are several instances wherein one discovers only at the end of a long disquisition that its purpose all along has been strictly limited, whereas whole paragraphs read like sweeping generalizations.

Some of the more physical concepts are especially valuable. One is our natural tendency to concentrate upon the 'islands' of decreasing entropy ("Let us eat and drink, for to-morrow we die", in fact), rather than upon the 'oceans' for which $S = k \log W$. Here 'Baltzmann' for Boltzmann (repeated in the index) is a deplorable slip, although the status of the *Wärmetod* needs some thought at the moment. This is on account of 'open systems' of thermodynamics recently investigated by Bertalanffy and others; they may turn out to be the thermodynamics of the biological world, and hence of major consequence for society and for cybernetics.

Prof. Wiener is forthright about educational matters. We all come under his lash; but the heaviest strokes are reserved for his own country. The present reviewer, however, would like to record his delight—in visiting Prof. Wiener's own institution on two separate occasions—in finding so much provision for the study of the humanities (in the midst of technics), and for the liberal arts; and again, there is the University of Buffalo, straining both its finances and its academic man-power in a noble effort to give individual teaching its highest expression. This, too, encourages the hope that all is not lost.

For the rest, Prof. Wiener's apocalyptic utterances will doubtless bide their time, for they speak of things perhaps unknowable as yet. F. I. G. Rawlins

# BRITAIN'S SCIENTIFIC SHRINES (6)

By Eng.-Captain EDGAR C. SMITH, O.B.E., R.N.

## THE NORTH-WESTERN COUNTIES

AMONG the men of science who passed their lives in the north of England, a special place belongs to the young clergyman Jeremiah Horrocks (1619 ?–41) and his friend William Crabtree (1610–42 ?), the first of mankind to observe the passage of the planet Venus across the sun's disk. Both were Lancashire men, Horrocks being a native of Toxteth, now within the boundaries of Liverpool, and Crabtree a native of Broughton, near Manchester. The story of their achievement is fully told in Grant's "History of Physical Astronomy". From 1632 until 1635 Horrocks was at Emmanuel College, Cambridge. Home again, he became a tutor, then went as curate to Hoole, eight miles south-west of Preston. Crabtree, on the other hand, was a clothier, but by the age of twenty-six was in correspondence with Horrocks. Their calculations led to the prediction that the transit would occur on Sunday, November 24, 1639, and both prepared to observe it, one at Hoole, the other at Broughton. Favoured by breaks in the clouds at the critical time, both were successful and, as Grant wrote: "Thus did two young men, cultivating astronomy together in a state of almost complete seclusion in one of the northern counties of England, enjoy the privilege of witnessing a phenomenon which human eyes had never before beheld, and which no one was destined again to see until more than a hundred years had passed away". What Horrocks might have achieved had he lived longer no one can say, but his early death, on January 3, 1641, must be regarded as one of the great losses to science in Britain. Crabtree also passed away within a year or two, and owing to the upheaval of the Civil War, the papers and correspondence of both barely escaped destruction. Though in a letter sent to King George III in February 1768, asking for assistance in observing the transit of 1769, the Royal Society referred to Horrocks, neither then, nor for long afterwards, was anything done to honour Horrocks's memory, and it remained for the Lancashire gardener, weaver and scientific lecturer, Moses Holden (1777–1864), to erect at his own expense in 1826 a memorial to Horrocks in St. Michael's Church, Toxteth. Later on, in 1859, a memorial chapel and window were added to Hoole Church, and in 1879, when the transits of 1874 and 1882 were attracting much attention, a tablet with an inscription by Dean Stanley was placed at the west end of Westminster Abbey. Four years later, one of the frescoes by Ford Madox Brown in Manchester Town Hall was devoted to Crabtree and his observation of the transit.

Other frescoes in the Manchester Town Hall recall the work of the canal builders, Brindley and the Duke of Bridgewater, John Kay of Bury, the inventor of the 'fly shuttle', and Manchester's most famous man of science, the Quaker teacher, chemist and physicist, John Dalton. There was never any likelihood of Dalton's work being forgotten, for after his death on July 27, 1844, wrote Lord Playfair, "Manchester gave him the honours of a king. His body lay in state and his funeral was like that of a monarch". His massive granite tomb is in Ardwick Cemetery and his statue, together with that of his pupil and successor, James Prescott Joule, stands in the entrance to the Town Hall. Dalton hailed from Cumberland, being born on September 6, 1766, at Eaglesfield, near Cockermouth, and near by in the graveyard of Pardshaw Hall is a memorial to him erected a few years ago by the Society of Friends. Nearly a century before Dalton was born, Cumberland was the birthplace of another famous Quaker scientific worker, George Graham (1673–1751), who was born at Horsgills, in the parish of Kirklinton; but he went to London to serve an apprenticeship, and now lies with his master, Thomas Tompion, in Westminster Abbey, whither he was carried on the night of November 24, 1751, his pall being supported "by Dr. Knight, Mr. Watson, Mr. Canton, Mr. Short, fellows of the R.S., Mr. Catlyn, and Mr. Bird, intimate friends of his". In the eighteenth century, when the majority of British natural philosophers devoted themselves to physical inquiries and astronomy, London was a great centre for clock, instrument and telescope makers, among whom none had a higher reputation than Graham and his fellows from the North Country, among whom were John Harrison (1693–1776), of Yorkshire; John Bird (1709–76), a native of Durham; Jesse Ramsden (1735–1800), another Yorkshireman; Thomas Earnshaw (1749–1829), who was born at Ashton-under-Lyne, Lancashire; and Edward Troughton (1753–1835), like Graham a native of Cumberland. The clocks, chronometers, sextants and telescopes of these great artists were found in ships and observatories all over the world. A bust of Troughton is in the keeping of the Royal Observatory, Greenwich, the tomb of John Harrison in Hampstead churchyard was reconstructed in 1879 by the Worshipful Company of Clockmakers, and in 1931 the Company joined with the British Horological Institute in erecting a tablet to Earnshaw outside the church of St. Giles-in-the-Fields, Bloomsbury, where Earnshaw worshipped and was buried. Of the other men of science of whom Cumberland can boast, Dr. William Browning (1711–1800) practised for many years at Whitehaven, where he made experiments on the gases from mines. In 1766 he was awarded the Copley Medal of the Royal Society for his "Experimental Enquiry into the Mineral Elastic Spirit or Air contained in Spa Water", and a few years later assisted Franklin with his experiments on stilling the waves of Derwentwater by the use of oil. Browning died in retirement at Ormathwaite, near Keswick. From Whitbeck in Cumberland came another original and versatile man of science, the Rev. William Pearson (1767–1847), a promoter of the Royal Institution, a founder of the Astronomical Society, and the owner of an observatory at South Kilworth, Leicestershire, of which he was rector for thirty years and in the church of which he has a memorial.

There are other names which might perhaps be included in this brief review of the worthies of Cumberland; but no excuse is needed for recalling that it was at Stoneraise Place, Wigton, on July 2, 1862, that Sir William Bragg was born. From 1923 he was Fullerian professor at the Royal Institution and director of the Davy Faraday Research Labora-

tory and during 1935–40 president of the Royal Society. He died on March 12, 1942.

Westmorland no less than Cumberland had her mathematicians and experimentalists, among whom were William Gibson (1720–91), a native of Boulton, near Appleby; Adam Walker (1731 ?–1821), who was born at Patterdale; and the blind John Gough (1757–1825), of Kendal. All having taught themselves taught others. Gibson, who had a school at Cartmel in Lancashire, was a correspondent with many other mathematicians; Adam Walker became a successful lecturer on scientific subjects in London and at Westminster, Eton, Winchester and other schools; and Gough, at his school at Kendal, counted among his pupils Dalton and Whewell. Though blind from the age of three, Gough made many contributions to the *Transactions of the Manchester Literary and Philosophical Society* and other periodicals. Among Walker's friends was the painter George Romney, who died in Kendal in 1802, and in the National Portrait Gallery is Romney's picture of Walker, his wife and daughter and three sons, the youngest of whom, Deane Franklin Walker (1778–1865), continued his father's lectures at the great public schools. The contemporaries of Gibson, Walker and Gough included the Rev. Anthony Shepherd (1721–96), a native of Kendal, who became Plumian professor at Cambridge, master of mechanics to George III and canon of Windsor; Bishop Richard Watson (1737–1816), who was born at Heversham and is buried and commemorated in Windermere Church; and Thomas Garnett (1766–1802), of Casterton, who was trained as a surgeon by John Dawson (1734–1820), of Sedburgh, and at Edinburgh, and became the first professor of natural philosophy in the Andersonian Institution, Glasgow, and also the first professor of natural philosophy in the Royal Institution. His early death was due to typhus fever. Watson, like Shepherd, was educated at Cambridge, and though, as he himself admitted, he knew nothing of chemistry, was appointed professor of that subject. The post, however, was admirably filled, and Watson afterwards published volumes of chemical essays. To him the Navy owed its first lightning conductor, a chain of copper rods, one end of which, on the approach of a thunderstorm, was triced to the masthead while the other end was allowed to trail in the sea. Like others, Watson was a pluralist—he held several livings and during 1782–87 was Bishop of Llandaff. He died at his estate, Calgarth Park, Westmorland.

The mention of that rather remarkable character, John Dawson, justifies a short detour from Westmorland to Sedburgh and Dent in the north-west of Yorkshire, for Dawson, overcoming his early lack of schooling, not only became a competent surgeon but also a good mathematician, who saw several of his private pupils become senior wranglers. Among this group was Adam Sedgwick (1785–1873), the great geologist, son of the curate of Dent, in the beautiful Dentdale, which was described in a letter by Airy in 1841 and again by A. C. Ramsay in a letter in 1865, who from "Dent, Kendal" wrote: "to old Adam Sedgwick telling him how pleased I am to be in his old home . . .". Sedgwick was perhaps the most popular man in Cambridge, and Geikie wrote of his "hard featured yet noble face, eyes like an eagle's, manly alike in body and mind, full of enthusiasm, ready and graphic in talk, generous and sympathetic, shrinking from no toil either at home or abroad in furtherance of his chosen branch of science". He was buried in Trinity College Chapel, and his name is perpetuated by the Sedgwick Museum of Geology, in which is his statue.

Entering Lancashire from Westmorland, just across the border are found Whittington, the birthplace of the shoemaker, gunner, experimenter and lecturer, William Sturgeon (1783–1850), who gave the world its first electromagnet, and Lindale, where can be seen the cast-iron column erected to the famous iron-master John Wilkinson, who lies in a cast-iron coffin not far away. Another column, but of stone and fashioned like a lighthouse, can be seen on Hoad Hill, Ulverston. This was erected in 1850 in memory of Sir John Barrow (1764–1848), who, long the secretary of the Admiralty, promoted Arctic exploration and was the virtual founder in 1830 of the Royal Geographical Society. Barrow's birthplace was a small cottage at Dragley Beck, Ulverston, and in this is a tablet recalling his services and referring to the remarkable vigour of his mind. The cottage was presented to Barrow's son, who gave it to the Ulverston Urban District Council together with the plans of the monument on Hoad Hill. Another spot near Ulverston, Lowick, was the birthplace of Dr. Joshua King (1778–1857), another of Gough's pupils. He became a fellow of Queens' College, Cambridge, and died in the President's Lodge; he was the predecessor of Sir George Stokes in the Lucasian chair of mathematics. Sturgeon's career began with his apprenticeship to a harsh and mean shoemaker, but it took him into the Westmorland Militia, into the Royal Artillery at Woolwich, to the East India Company's College at Addiscombe, to the Adelaide Gallery of Practical Science in London, and in 1840 to the Royal Victoria Gallery at Manchester. Known to Dalton and Joule and a contributor to the *Transactions of the Manchester Literary and Philosophical Society*, he died as poor as when he was born, and was buried at Prestwich, near Manchester. In 1847, it is recorded, he gave four lectures on electricity and optics at the Green Dragon Inn, Kirkby Lonsdale, Westmorland, two miles from his birthplace, and in Kirkby Lonsdale Church is a marble tablet to his memory.

If a century ago Sedgwick was the most popular man in Cambridge, William Whewell (1794–1866), who was born at Lancaster, was certainly the most masterful. His energy, learning and influence were immense, and he ruled Trinity College like a captain does a battleship. The son of a carpenter, he attended Lancaster Grammar School, and before entering the University of Cambridge read mathematics with John Gough. From his eighteenth year Cambridge was his home. Sir Francis Galton, who belonged to a younger generation, and who graduated from Trinity College in 1844, in his "Memories of my Life", gave an amusing account of the great man courting Lady Affleck, and quoted the lines:

> "You may roam where you will through the realms of infinity
> And find nothing so great as the Master of Trinity"

which he had from Lord Kelvin; he also said that readers of Whewell's "Life" would gather from it "little idea of the rough power of the man and his too frequent overbearing attitude. In after days," Galton added, "he invited me to the Lodge, where I found him unexpectedly gracious." To-day, a statue of Whewell stands in the ante-chapel of Trinity College beside those of Bacon, Barrow, Newton,

Macaulay and Tennyson, and in Lancaster Church he has a memorial window. Lancaster was also the birthplace of Whewell's famous friend and contemporary, Sir Richard Owen (1804–92), whose destiny took him first to Edinburgh and then to London. Yet another son of Lancaster was Henry Cort (1740–1800), the Navy Agent who revolutionized the wrought-iron industry and gave the new race of engineers and shipbuilders the bars and plates needed for their rails, boilers, engines, bridges and ships. Misfortune dogged his later years, and like many another benefactor who has died poor, he passed away unhonoured and unsung. His grave in Hampstead churchyard long lay neglected, until in 1905 an American citizen, Charles H. Morgan (1831–1911), of Worcester, Mass., a past president of the American Institute of Mining Engineers, found and renovated the tombstone and provided a bronze tablet for the porch of the church at Hampstead and another for the church at Lancaster.

From Lancaster to Preston is a matter of eighteen miles, and at Preston begins the great manufacturing area associated with the eighteenth century pioneers of the textile industry. Preston itself was the birthplace of Richard Arkwright; Blackburn and Accrington were the scene of the early labours of James Hargreaves (1720 ?–78). Bury was the home of John Kay (1704–?), and Bolton the birthplace of Samuel Crompton (1753–1827). Hargreaves appears to have no memorial; but Kay's cottage is still standing and the Bury and District Textile Society is trying to have it preserved. Bolton has long done justice to the memory of Crompton, for his statue stands in one of its squares and his old home, "Hall-i'-th'-Wood", a small timbered mansion, has been preserved through the action of another famous son of Bolton, the first Lord Leverhulme (1851–1925). Horrocks's connexion with Hoole, near Preston, has already been mentioned, and Preston now, in Moor Park, has its own Jeremiah Horrocks Observatory. To the north of the town at Woodplumpton is to be seen the memorial to the clergyman's son, Lieutenant Henry Foster (1796–1831), R.N., who accidentally lost his life in the Chargres River. He had entered the Navy at the age of sixteen as a volunteer, and his scientific work during Arctic voyages had gained for him in 1824 the fellowship of the Royal Society and in 1827 the Copley Medal. In 1828, given the command of the *Chanticleer*, he set out on a long voyage of scientific research from which he never returned.

"At the time of Crompton's birth," said *The Times* on the occasion of his centenary in 1927, "Lancashire was a wild stretch of country and the towns in it contemptible; at the time of his death it was a hive of prosperity." This prosperity was shown by the great increase in population. It is believed that in 1700 the five most populous counties of England were Middlesex, Somerset, Gloucestershire, Wiltshire and Northamptonshire; in 1800 they were Middlesex, Lancashire, the West Riding of Yorkshire, Staffordshire and Warwickshire. With this increase of population had come the construction of canals, the improvement of roads and the speeding-up of traffic. No place felt the impact of the Industrial Revolution more than Manchester, the population of which increased from 22,000 in 1780 to 160,000 in 1824.

It was the beginning of this period which saw, in 1781, the foundation of the Manchester Literary and Philosophical Society, which became almost a Royal Society for the north-west. Since the days of Crabtree, until the middle of the eighteenth century, Manchester had produced few if any notable men of science; but with the founding of the Literary and Philosophical Society it became a centre for the scientifically minded, and the story of the Society and of the College founded by the will of John Owens (1790–1846), and of the University to which the College gave birth, would fill many a volume. But all that can be done here is to recall the beginnings of things and some of the men who brought them to pass. As in so many matters, it was the medical men who set the ball rolling, and the two names most closely associated with the founding of the Society are those of Dr. Thomas Percival (1740–1804) and the surgeon-apothecary Thomas Henry (1734–1816). It was at the house of Percival that the Society was brought into being; it was Percival who was its first president and it was Henry who was its first secretary. Born at Warrington, and a student of the Warrington Academy, where Priestley at one time taught, Percival took his degree of M.D. at Leyden in 1765 and two years later set up in practice in Manchester, becoming known as one of her most public-spirited citizens. He died in Manchester but was buried in Warrington Church. Henry was no less active in the interests of science and the people of Manchester, and when he died he left a son, Dr. William Henry (1774–1836), who, like his contemporary Dalton, added greatly to the fame of the Philosophical Society and gained for himself the coveted Copley Medal. Refined in manner, eloquent in speech, his society was much coveted. "He was an accomplished and original man; one who advanced science and took a prominent place among the chemists of the age." It was in 1794 that Dalton became a member of the Society, and for more than forty years it was his scientific home. Within its walls he taught, lectured, wrote and experimented and was its president from the time of the death of Thomas Henry, being elected each year unanimously save for a single vote—his own! Joule, who was born at Salford in 1818 and died at Sale, Cheshire, in 1889, of course, belonged to a later generation, but it was on him Dalton's mantle fell.

From 1799 onwards, the home of the Society was at 36 George Street, and when the Society in 1931 celebrated its one hundred and fiftieth birthday, it was addressed by Sir J. J. Thomson (1856–1940), who was born at Cheetham, Manchester. At that time it was said that No. 36 George Street "has externally an old world appearance, with pillars in front and a porch finely panelled in mahogany. Internally it is most attractive and preserves an atmosphere of studious calm in a district long ago given up to commercial activities. . . . Of Dalton relics the Society has an unequalled collection." On the night of December 24, 1940, during an air-raid, the building, its memorial tablet to Percival, its busts and portraits of distinguished men, and its library of 50,000 volumes, were completely destroyed, and from the debris all that was recovered relating to Dalton was his watch, a eudiometer and some charred papers. The same fate also overtook the Cross Street Unitarian Chapel, where both the Henrys were buried.

The temptation is to continue the story of the scientific worthies of south Lancashire, and to review the work of the founders of her great chemical industry, to visit the haunts of some of her famous engineers, to trace the birth and

development of the scientific institutions of Liverpool and to say something of the interesting Liverpool Observatory and Tidal Institute, which, like the Royal Greenwich Observatory, was founded in the interests of navigation.

But perhaps sufficient has been said of the work of the pioneers in a county which, in more recent times, has seen some of the most notable triumphs of the methods of scientific research of which Dalton and Joule were such masters.

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## WORLD COMMUNICATIONS: THE IMPACT OF SPEED

THE Division for Social and International Relations of Science of the British Association held an open meeting on "World Communications: The Impact of Speed" in the Pollock Hall, University of Edinburgh, on August 13; Sir Harold Hartley was in the chair.

Sir Edward Appleton, principal and vice chancellor of the University of Edinburgh, opened the discussion by sketching briefly the technical advances of radio which permit intelligence to girdle the earth almost instantaneously. He emphasized that these changes have all occurred within approximately the past half-century. Marconi's morse signals were the first relatively simple step; but even they were capable of trans-Atlantic transmission by the then unexplained natural bonus provided by the Heaviside layer, which reflects radio waves back to earth and continues to zig-zag them around its circumference. It required, however, the development of the radio valve to make the more complicated speech and music signals amenable to transmission.

The importance of research into the reflecting properties of the ionosphere in the technical advance of international radio communications was emphasized by Sir Edward, and he explained how its variation demands the use of compromise wave-lengths the value of which changes over the twenty-four hours. Ionospheric 'radio weather' is subject, however, only to slow and small change, which, after twenty years research, is predictable.

The competition for the short wave bands which girdle the earth is tremendous, because of their unique value to instantaneous world-wide transmission, and this impact of speed encourages disregard of international agreement of wave-bands, especially for purposes of propaganda.

For broadcasting within fairly narrow national boundaries, the medium wave-lengths are favoured. But here the increase of night-range caused by reflexion creates the international interference nuisance, and for this reason very short, non-interfering, escaping wave-lengths are being favoured for broadcasting speech and vision domestically. They would also relieve the congestion on the longer wave bands. The impact of speed is the demand for more people to use more of it.

Concern is being felt about the amount of radio noise and the need to reduce the unnecessary element in it. The prime need for simple code message, speech or television is to convey it untrammelled. There is enough radio noise inherent in broadcasting. In addition, the wastage of radio channel space on propaganda was deplored by Sir Edward, for large areas must be flooded with strong signals to reach inferior receivers. If the speed of radio communications could be accompanied by world peace and co-operation, greater radio efficiency would result. Verbiage in the air could be cut down to advantage, more especially in English. These points emphasized the urge to economy in radio channel space which these much-sought speedy communications demand.

Sir Edward concluded that the disadvantages faced by radio to-day are largely of man's own making. Science is neutral and will continue to seek truth, and, if the impact of speed is to be for good, it is for ourselves to make it so.

Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, followed, tracing the impact of speed in aviation. The 10 miles per hour flight of the Wright Brothers heralded a transport revolution because of hitherto unsurmountable barriers being lowered. But the Wright aircraft was all excrescences, and, as these were shorn away in later types, ever-improving speeds were achieved. Cockpits were built in, struts and bracing wires disappeared, monoplane replaced biplane, undercarriages were retracted, and all manner of gear was built flush in the structure to give the streamlined modern aircraft. But with the streamlining of the aerodynamicist had to come the research of the structural engineer and engine designer to reduce weight as well as drag. With increasing speed comes increasing drag; but an economic margin of pay load and range must be maintained for military or commercial purposes, and the impact of speed is to induce the collaboration of all scientific workers to reduce structural weight, engine weight per horse power and fuel consumption. Metallurgist, structural engineer and aero-engine makers have combined to reduce weight, and fuel consumption was reduced until the arrival of 100 octane fuel.

Profile drag has been cut to a minimum by wind-tunnel experiment and the mathematical analysis of results by aerodynamicists.

Despite all these gains in speed, a halt to increase would have come in 1945, but for Whittle's jet engine, with its high thrust and propulsive efficiency increasing with speed, enabling the shock waves near the sonic barrier to be overcome. The propeller-driven aircraft was unlikely to have exceeded 550 miles per hour.

New aerodynamic design with swept-back wing, delaying onset of shock waves, combined with the use of thin wings, slim fuselage, swept-back tail and fin surfaces and jet engines have created the new efficiency embodied in the British Comet transport aircraft, the impact of the speed of which will bring London within 18 hours of Johannesburg.

The historical review of world communications over the past half-century having been traced by the first two speakers, Dr. Edward Warner, director of the International Civil Aviation Organization, considered the impact of speed on contemporary world society, and especially the impact of the aeroplane's speed. Here he gave a warning that increased speed is not the only significant characteristic of air transport. Of all the revolutionary changes in world transport, aircraft spell the greatest flexibility and emancipation from routes and permanent way.

Air transport has created quite new social, economic and political conditions. The 'remote places of the earth' have become economically accessible and new culture contacts have sprung up, with inevitable awakening of interest in world affairs for remote peoples. The aeroplane has brought medical services where there were none before. Commercial relations,

economically prohibited hitherto, have flourished, and the aeroplane has become the *raison d'être* for many new communities and for the revitalization or altered status of older ones. This is true even in such densely populated areas as the United Kingdom, as witness the Scottish Islands. This is the more spectacular impact of speed and flexibility in air transport.

Of more consequence is sheer speed between established centres of population and commerce. Transport of persons between such areas may be for personal or business reasons, each with its peculiar consequences. Air transport has eliminated the time-factor as a deterrent to travel or shipment, but economic deterrents remain. Cost per mile compares favourably with other modes of transport, but cost per hour is enormously higher, and for this reason helicopter services, although technically possible, are unlikely to enlarge the dormitory radius of large cities. International tourism has not advanced because of air travel, for although the time-factor is favourable, the cost remains prohibitive, and total trans-Atlantic travel has not, for example, increased with the possible air speed of the journey. Dr. Warner doubted whether an increase in real income in the higher ranges would be accompanied by a proportionate increase in air travel for personal reasons, such as was the case when the motor-car developed. Drastic reduction in cost or increase in income would be required before inter-continental air travellers could be numbered in millions. Goods, even more than passengers, have to be able to stand high freight-rates by air.

Low costs might promote better inter-continental understanding, assuming it is admitted that the thousands of intra-continental air travellers in Europe have promoted goodwill between their nations. Thousands fly between Britain, France, and the Low Countries, but few go thence as far as Peru or Thailand for personal reasons. But travel is no panacea for world relations. The quality of the traveller will be the measure of its success, and the greater the cultural difference the greater is the need for the understanding which the impact of speed can provide. The disadvantage may be that with greater potentiality of range may come a more superficial knowledge of countries and peoples, to the detriment of understanding. The man on the camel may travel slowly, but he has the time to observe and digest. The antidote is in better education and preparation for travel in order to absorb the lessons to be learned abroad.

The greatest consequence of speedy air travel, however, lies in the transportation of statesmen and functional specialists. It facilitates centralization of an authority covering huge areas. It makes for the mobility of the narrow specialist and the meeting of principals of States. With these men time is at a premium and cost is disregarded. It may be that this creates a tendency to enter prematurely into negotiations and is a debatable asset. Here again it is for man to muster the impact of speed on his side and use it wisely. It could be used for promoting the decentralization of government and population, considered by many to be so desirable, to promote healthy regionalism and disseminate cultural amenities.

Among the indubitable benefits of air transport is the ability to respond quickly to an emergency where peace is threatened, and neutral commissions can quickly attend a trouble-spot while negotiation is possible. Greater use may be made of specialist knowledge with this greater speed and mobility. In business it allows quick personal inspection abroad, quick demonstrations in the field, access to remote markets, and should promote the realization of the need for healthy international trade as opposed to domestic protection. The aeroplane had, however, the misfortune to grow up in an era when States were struggling for autarchy, when its military potential made it suspect, and sovereign rights were jealously guarded. Since 1945, prospects have brightened for co-operation, and the further impact of speed envisaged by Sir Ben Lockspeiser might make a critical difference to the travelling statesman.

In the following discussion Mr. Ritchie Calder, chairman of the Division for the Social and International Relations of Science, suggested that the impact of speed demands a geo-psychology—a study of the impact on world society of high-speed communications—and still further, physiological research into the effect of high speed on the ordinary traveller. He doubted whether the effects of speed, psychological or physiological, on the normal man are understood; he remains tense and strained after a long air flight, and occasionally feels after sudden translation that he has left his 'psyche' behind.

Mr. Calder wondered whether much of the bitterness and rancour of international diplomacy may be attributable to physiological and psychological maladjustment, due to the impact of speed, rather than to political irritability. He wished to have enlightenment on whether the repeated 'breakfast-table crisis' creates either an unhealthy and prolonged nervous tension or an equally unhealthy apathy to international danger. He wished for clarification of the impact of speed. He, too, emphasized the neutrality of science, and pointed out that man's lying propaganda on the air can be even more devastating than his misuse of applied science in destructive weapons.

Historically, crises often die naturally before they can be developed; to-day, each international crisis brings immediate and often dangerous reaction. Mr. Calder fears, too, that speedy communications may be to the detriment of local culture, that a uniform and dull standardized culture may result, devoid of all graciousness and pleasing eccentricity. The white light of universal enlightenment includes in its spectrum the colours of all the cultures of the world. He asked whether we can reasonably impose the impact of speed on primitive societies and offer them our neuroses and physical sicknesses with it; he suggested that one of the most serious problems of scientific men is to discover the impact of speed in world communications upon our society.

Prof. D. W. Bronk, president of the Johns Hopkins University and chairman-elect of the American Association for the Advancement of Science, as a physiologist suggested that the questions Mr. Calder had posed are as yet unanswerable, though he doubted whether the 'psyche' is temporarily left behind on sudden translation from continent to continent. The impact of speed certainly demands of man quick decisions on his day-to-day problems, and a quickening in his mental reactions; but he also made it clear that the essentials for bringing world order from chaos are present if we chose to use them. The same swift aeroplane can bomb an enemy or carry a sick friend to a remote hospital.

Prof. A. V. Hill, president-elect of the British Association, then gave a warning that there is a limit

to the rate at which man can accommodate himself to faster travel. On foot, man has improved on the mile running record by 12 seconds, in the same time as he has taken to change from 10 miles per hour to 600 miles per hour flight. The effect of such rapid change is bound to be tiring and inconducive to sustained first-class work. He mentioned that the accelerated process of burning frequently becomes an uncontrollable conflagration, and left his listeners to draw their own conclusions. Isolated wars and isolated diseases may now, with the impact of speed, get quickly into the general circulation with disastrous results. Speed has explosive tendencies and man should inquire into and attempt to control such tendency.

Dr. L. B. Cacciapuoti, deputy-director of the Social Science Department of the United Nations Educational, Scientific and Cultural Organization, winding up, struck a hopeful note, suggesting that the impact of speed will make for the quicker and wider dissemination of scientific knowledge in a manner similar to that following on the development of the art of printing. The impact of speed means that associations of scientific workers may now congregate from the corners of the earth, and with radio communication and air transport, no man of science need find the latest developments or the greatest men inaccessible to him. Such easy access to discuss calmly, with the aim of seeking truth about natural phenomena, promotes fraternal feeling transcending artificial political and racial barriers. Dr. Cacciapuoti's fear is that over-specialization may defeat this end by losing sight of the wholeness of science; but here again he hoped the impact of speed would overcome the difficulty, by spreading scientific knowledge, below technical specialization, but at a high level. He professed great faith in the potential for international association of men of science which the impact of speed on world communications makes possible, and in which he trusted lies the germ of world peace and understanding.

John MacPherson

## HISTORY OF CULTIVATED PLANTS

A SERIES of papers on cultivated plants, with special reference to their origins and histories, was given in Section K (Botany) of the British Association at the recent Edinburgh meeting.

Sir John Milne Home opened with a discussion of the introduction of exotic conifers into Great Britain and their influence on forestry. Several of these have been long established in Britain; thus, the Norway spruce (*Picea abies*), which is suited to the rainfall, was introduced about four hundred years ago. Other species long known in cultivation in the British Isles include the sitka spruce, Japanese larch, Douglas fir, giant silver fir, western hemlock and the western arborvitæ. More recently many species have been, and are being, given trials; but their value as forest trees in Britain remains more or less uncertain. Included in this category are the Monterey cypress, the Serbian and oriental spruces, two firs (*Abies amabilis* and *A. nobilis*), and the giant redwood. Many of the new introductions thrive well under certain conditions, but have limits to their sylvicultural value. Exotic conifers have had a great influence on British forestry, and this may be increased in the future.

Mr. J. M. S. Potter dealt with the history of the apple. It is not possible to say exactly where the cultivated apple originated; but it spread through Europe from east to west. *Pyrus malus* (*Malus communis*) was certainly one of the most important of its ancestors; but botanists are not entirely in agreement regarding the classification of the subdivisions of this aggregate species. The Romans may have introduced the cultivated apple to Britain. It was widely grown in monastery gardens, and since the monks were in contact with monasteries on the Continent new sorts of apples were frequently introduced. South-east England, from its nearness to the Continent and by the immigration of refugees, became a centre of fruit-growing in Tudor times. Many names of cultivated apple varieties are of French or Flemish origin. The distribution of apple cultivation on a commercial scale in Britain largely depends on ecological factors; dessert apples are mainly grown in drier areas, since fungal diseases can be more easily controlled than where the rainfall is heavy. Turning to more recent times, T. A. Knight may be regarded as the father of fruit breeding. In 1894, Pickering, at Woburn, started the first modern studies on fruit research in Britain, and in the succeeding years three institutions dealing with research in fruit were founded: the Long Ashton Research Station in 1903, the John Innes Horticultural Institution in 1910, and the East Malling Research Station in 1912. Apple cultivation has been revolutionized by studies on rootstocks, fertilizer treatment, pruning methods, general orchard practice, diseases and pests, fertility and sterility, and the breeding of new varieties. It remains to be seen if scientific research will result in the production of varieties better than those left to us by our forefathers.

The subject of olives was considered by Dr. W. B. Turrill, who said that both the wild and cultivated plants are characteristic of the countries bordering the Mediterranean Sea. The cultivated olive is of very great importance to the countries of southern Europe, northern Africa and western Asia for its fruits and the oil produced from these. Before the Second World War the area covered by olive plantations was estimated at 22,580 square miles, yielding 160,000 tons of oil and 20,000 tons of fruit for table use. Spain, Italy, French North Africa and Greece were the largest producers in the order named. *Olea europæa*, the common olive, is an evergreen tree up to fifteen metres in height or a shrub. Its opposite leaves are narrowly elliptic to linear-lanceolate of a subdued green on the adaxial and whitish grey on the abaxial surface. Its small white flowers are produced in May, and the best oil comes from the pulp of the drupes. The tree requires warm, well-drained soil, and responds quickly to proper treatment, especially to pruning. A large number of varieties, based on fruit shape, have been named and described. These are mainly propagated by vegetative means, and the varieties, as with so many other cultispecies, therefore occur as clones. The wild olives of the macchie, usually referred to as var. *oleaster*, are a heterogeneous assemblage, a mixture of microvarieties that need detailed cytogenetical investigation. The two or three published records of chromosome counts give $2n = 46$; but all are based on cultivated material.

About eighty-five species have been described within the genus *Olea*; but recent research shows that many of these are not valid species. The genus is

mainly tropical, apart from *C. europæa*, and ranges through tropical and south Africa, the Mascarenes, western China, the Indian subcontinent, Malaya and Australasia. It does not occur in the New World. *Olea chrysophylla*, to which several species have been reduced, has the widest range throughout the greater part of Africa south of the Sahara and in Asia from Afghanistan to western China. In the Sudan and the southern Sahara there are plants intermediate between *O. chrysophylla* and *O. europæa*, and others occur also in Madeira. In particular, specimens named *Olea laperrini* from the Hoggar Mountains and from Jebel Marra are of great interest.

The place, time and immediate ancestry of the cultivated olive are unknown. It is frequently referred to in the Old Testament and in ancient Greek literature. The legends of Greek mythology point to its origin outside Greece and its introduction as a plant already in full cultivation. In ancient Egypt, the olive was certainly known, even in predynastic times, and recent archæological evidence suggests that it was of greater importance than was formerly thought. Unfortunately, there is no known reliable evidence of *Olea* as fossils, and the few cytological studies published throw no light on the origin of the cultivated olive. After a careful consideration of various possibilities, it is concluded that *Olea europæa* may have arisen from *O. chrysophylla* in northern tropical Africa and that it was introduced into the countries of the Mediterranean Basin via Egypt and then Crete or Palestine, Syria and Asia Minor.

In outlining the history of the more important cereals, Dr. G. D. H. Bell pointed out that the chief centres of origin of these are the Mediterranean basin, Persia, Abyssinia, far-eastern Asia, south-eastern Asia, central Asia, and South America. These centres for the most part coincide with areas of ancient civilization. The genera mainly considered by Dr. Bell were *Triticum*, *Secale*, *Hordeum* and *Avena*. The oats are taxonomically quite distinct from the first three of these genera, for which a prototype with $2n = 14$ chromosomes has to be postulated. In the genus *Triticum*, mutations gave rise to various species and were followed by polyploidy. Wheat, however, did not evolve within the one genus. A cross between a diploid *Triticum* and a diploid *Agropyron* followed by allopolyploidy gave the chromosome number of $2n = 28$. A second intergeneric cross between a *Triticum* with $2n = 28$ and an *Aegilops* with $2n = 14$, again followed by chromosome doubling, gave the important wheats with $2n = 42$. Cytogenetical researches on barley and rye have thrown much light on the constitution and origin of these cereals; but the history of cultivated oats is less well understood in spite of the fact that they are of more recent origin than the other plants here considered. The infinite range of morphological and ecological types of the cultivated cereals was emphasized.

Dr. J. G. Hawkes reminded the meeting that the potato was introduced into Europe at the end of the sixteenth century and was regarded as one species until the early part of this century. Now about fifteen species are recognized in place of *Solanum tuberosum*. The basic chromosome number of these is $x = 12$. South Peru and north Bolivia, centres of ancient Andean civilizations, are included in the range of the *Tuberosa* series. Chromosome numbers ranging from diploid to pentaploid occur in the cultivated potatoes and to hexaploid in wild species. Probably wild tetraploids were taken into cultivation. In nearly all areas of western South America there occur wild potatoes with long stolons. These grow in places where competition with natural vegetation is not great and where the soil is rich in nitrogen. Hence they take full advantage of areas disturbed by man. They survive from one season to the next by pieces of the long stolons being left behind in the soil by the early users of the tubers. The original ancestor of the cultivated potato, however, probably no longer exists—it was all taken into cultivation. No doubt the modern potatoes show little resemblance to the first cultivated plants.

## ANIMALS AND FORESTRY

SECTIONS D (Zoology) and K* (Forestry) of the British Association held a combined symposium at the recent meeting in Edinburgh in order to discuss the relation of animals to forestry. Dr. F. Fraser Darling, a member of the Scottish Committee of Nature Conservancy and formerly director of the West Highland Survey, opening the symposium with a contribution on mammals, said that the relation of mammals to forest growth is a critical one, for its survival or extinction, and it is one of the most dramatic complexes in Nature. The advent of pastoral, agricultural and civilized man has complicated the situation ecologically. Forests are either climaxes or stages well on the way to the climax, a feature of which is the increasing variety of organic forms and degree of stability. This stability may be interpreted as self-regulation, and the biological system becomes a continuum. Climaxes are constantly being broken by natural catastrophes such as hurricane and fire, but in limited areas, so that the set-back in ecological succession creates edge effects and allows the continued existence of forms which could not endure in the absolute climax. The over-all biological picture is enriched by periodic natural catastrophe.

The profound benign or depressive influence of mammals in the natural chequerboard of climax forest, secondary growth and primary colonization is clearer if the animals are classified according to what they do—predators, browsers and grazers, rodents and insectivores. The predators as a group, of which several species have been lost by extinction, form the insurance company, ensuring the forest as a continuum by controlling the populations of rodents and grazers and browsers. The insectivores share with birds and predatory insects the control of invertebrate populations which tend to depress forest growth. Control is never absolute and no one species is critical; control rests with the complex. The depletion of the predators in the interests of particular forms of land use has endangered the maintenance of old forests and is a grave handicap to the establishment of new ones. Dr. Darling suggested that human ingenuity is not yet equal to controlling small rodents in an extensive habitat, for example, wood mice (*Apodemus*) and squirrels. Their vast numbers and fecundity, their smallness and capacity for evasion are too much for us. A good and varied stock of small carnivores is not only our best insurance but also the cheapest.

The grazers and browsers are comparatively few in numbers, but represent a considerable bio-mass. Although depressive to forest, a low density (the

ratio of 1 red deer to 133 acres or thereabout in the Forest of Fontainebleau was cited) may be positively useful. Nevertheless, said Dr. Darling, it is doubtful whether the new artificial forest of Britain can endure the red deer, or even the fallow. Natural forest as a continuum, used by man on a selective felling basis, can accommodate deer with advantage, but not the plantation intended to be clear-felled and replanted. Some North American forests were described, where the upset in natural predation on deer is leading to some serious situations through over-population. The success of Theodore Roosevelt's promotion of the sporting and sentimental status of deer has been immense in the United States, but there is a lag in public opinion between the conditions of scarcity half a century ago and those of the present day when, in a country of much secondary growth, there are probably more deer than there have ever been before. Dr. Darling asked for much more enlightened critical appreciation of forest health, which would make us sensitive to damage in woodlands before situations become irremediable. The animal populations are more flexible than the forest habitat. The deer-forest era in Scotland, which encouraged an artificially high density, was responsible for the slow death of much natural forest. Forest growth in our day needs constant and highly skilled wild-life management, and the woodlands of Britain are not getting it. The wild-life complex is an immanent entity, benign in habitat maintenance if it is in a state of gentle oscillation, but a menace to our own survival if a warped complex begins to oscillate violently and percussively.

Mr. J. M. D. Mackenzie, formerly of the Indian Forest Service, described his work with nest boxes for birds in woodlands in Britain. The 1¼-in. hole is desirable for many small species, and, though orientation is important, a clear fly-way to the box is more so. A desirable height for small boxes is 5–6 ft.; but the degree of human interference makes a height of 10–15 ft. much safer. There are specific preferences, for example, a concave bottom is essential for woodpeckers, which do not use nesting material. To get optimum numbers of birds (that is, below the level of intra-specific competition) a fifty per cent surplus of boxes is desirable. Spacing is important, not only for the species of birds but also for the size, species-type and age of the woodland. Mixed forest cut on a selection basis carries the biggest and most varied populations, a finding in line with Dr. Darling's remarks.

The employment of nest boxes, said Mr. Mackenzie, can throw light on problems of distribution, in that it would seem that the presence or absence of nesting sites is often crucial when food may appear abundant. The spread of the pied flycatcher is an interesting example in that this is a species on the increase, but one which has occupied some valleys only after the provision of boxes. The flycatchers arrive in Great Britain when other species have already occupied most of the nesting sites. Interspecific competition is real. In 1947, after the hard winter, resident tits using boxes in the Forest of Dean fell from 54 to 20. Migrant flycatchers rose from 39 to 54, doubtless taking advantage of vacant sites.

Mr. Mackenzie's paper, which was accompanied by interesting comparative graphs, showed that the careful use of nest boxes and the results to be obtained from them after a series of years can be useful tools in the hands of the investigator into problems of forest ecology involving the dynamics of avian populations and their insect prey—a field in which there is little certain knowledge at the present time.

Dr. R. N. Chrystal, of the Department of Forestry, University of Oxford, dealt with the role of insects in forestry. He divided the forest regions of the world into those of temperate and tropical regions, indicating that the temperate forests consist of large areas of conifers of various kinds, some pure hardwood stands, such as oak, beech and birch, and some mixtures of conifers and hardwoods, whereas the tropical forests consist mainly of mixed stands of hardwoods of varying types. The insects can be classified into clearly recognizable biological types—defoliators, bud and seed borers, bark and wood borers, and the immense host of predators and parasites which attack the other insects at all stages of their lives. Insect control, indeed, largely rests with the predatory and parasitic Hymenoptera and Coleoptera.

Insect attack on the growing stand is most obvious in the temperate regions and particularly in solid coniferous forests. It is much less severe in mixed conifer–hardwood stands and at a minimum in hardwood areas. Insect attacks on the highly complex mixtures of tropical jungle forests are negligible. Thus, Dr. Chrystal expressed in his own way the principle emphasized by Dr. Darling and endorsed by Mr. Mackenzie, that the climax mixed forest as a continuum can accommodate a vastly richer fauna than the coniferous stand which in Nature is but a successional phase. Dr. Chrystal drove his point home in discussing the plantation forestry which is being established in Britain, in parts of Europe and in the Antipodes. Faulty choice of species may lead to failure through insect attack—for example, silver fir in some parts of Britain and Denmark—and if we see things aright, such attacks should be looked upon as indicators of unsuitability of site rather than an uncomplicated building-up of insect assault. The artificial coniferous plantation is a hostage to fortune from the nursery to maturity, insects becoming pests which are innocuous in the natural forest. The wood wasp *Sirex* is attacking *Pinus radiata* in New Zealand and acts as carrier of a fungus which helps to cause death of the trees. The present laborious method of trapping *Hylobius* and *Hylastes* beetles with fresh pine logs and bark is quite unecological and must be looked upon as a makeshift until forestry establishment itself adopts ecological principles.

Britain has as yet suffered little compared with some of the coniferous forests of Europe and North America, and the root causes of insect attacks in these places has still to be accurately determined. Hurricanes, for example, favour virulent attacks on the fallen trees by several species of Coleoptera. Human warfare, causing neglect of forest hygiene, must also be considered as a contributory factor in the large-scale attack of bark beetles in the forests of central and southern Europe. Fire damage in the Landes of Gascony has helped to establish the conditions for attack by the spruce bark beetle, *Ips typographicus*. Conversely, killing attacks of bark beetles of the genus *Dendroctonus* increase fire risk. Drought is another predisposing factor to the build-up of beetle attack. The intermixture of aspen and birch with conifers is now recommended in America, and we are gradually reaching the notion in Great Britain that a conifer-deciduous ratio must be determined and put into practice. All would agree with Dr. Chrystal that such a departure from

the pure stand would be as pleasing to the eye as it would be some insurance against fire and insects.

Mr. A. B. Duncan, a landowner and member of the Nature Conservancy, discussed birds in relation to forestry and reached the conclusion that they are of little importance. He confessed to a greater interest in forestry in relation to birds, and described vividly the different associations of birds characteristic of different kinds and phases of forests and plantations. From the pipit–wheatear–merlin association of the bare moor, the very young plantation passes to the short-eared owl–kestrel association when voles are the prey, on to the willow warbler–yellow-hammer grouping and then the tit–chaffinch–wood-pigeon–crossbill phase. Prof. H. G. Champion, of Oxford, emphasized in discussion that as forestry gets into going order in Britain all these phases will be in evidence, and there should be no impoverishment of the avian fauna by destruction of habitat.

Sir Henry Beresford-Peirse, in summing up, remarked that the fact which crystallized from the symposium was the widely ramifying consequences of interference by man, and that we had much to learn as to how our inevitable continued interference might be wisely done.

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# SEPARATION OF STABLE ISOTOPES BY ELECTROMAGNETIC MEANS

By W. D. ALLEN

Atomic Energy Research Establishment

DURING the War, the urgent need for large amounts of fissile material led to developments which, under peace-time conditions, would have matured much more slowly, if at all. Among these developments was the electromagnetic separation plant at Oakridge[1], based upon the research and development at Berkeley under E. O. Lawrence. Before the War, the production of ion beams (usually proton beams) of currents up to a few milliamperes was a normal laboratory problem: also the analysis of ion beams in the mass spectrometer, with mean currents of $10^{-10}$ amp. The production of large amounts of uranium-235, however, can be achieved only by developing much larger currents at high resolution: and the accomplishment of this in the space of two to three years represented a remarkable achievement.

Since the War, some of the plant at Oakridge has been used for the separation or enhancement of a wide range of elements in quantities ranging from one to several hundred grams[2]. At Harwell, a small separator has been operating since 1948 on the separation of milligram quantities of the lighter elements, chiefly boron and lithium. In 1950 a larger plant, based in broad principle on the Berkeley design, began separation. In Denmark, and also in Sweden, two small separators have studied problems chiefly concerned with gaseous isotopes; and in Holland, a medium-sized separator is nearing production.

As regards the description of the American project, some of the fundamental research reports on the ion source have been collected together by Guthrie and Wakerling ("Characteristics of Electrical Discharges in Magnetic Fields." U.S. National Nuclear Energy Series, vol. 1–5); but most of the technical detail is still classified. Some general comments about the quality of the products may, however, be made, together with a description of the types of experiments in which separated isotopes have been used.

## Comparison with Other Methods

The performance of the present larger electromagnetic separation plants is that some tens of grams of almost all polyisotopic elements can be separated into enriched isotopes, the enrichment factor of which varies between approximately 20 and 1,000. As compared with other methods, the greatest advantage of this process is its versatility; in effect, the separation can be undertaken in a single stage of any element of which a vaporizable compound can be fed into the ion source. This means that almost all elements, except for a few in the platinum and rhodium groups, can be readily subjected to analysis. The other major advantage of the electromagnetic method is that all isotopes can be collected simultaneously: the range of mass is never very great (calcium, with six isotopes ranging from 40 to 48 has the widest relative spread), so that, provided the system of focusing covers a moderate range of mass, all the isotopes can be collected simultaneously—in theory. In practice, this sometimes involves minor technical difficulties; for the heavier elements, for example, the relative separation of neighbouring isotopes is small, and the close juxtaposition of many collectors is not easy. However, the difficulties are negligible compared with the problems which would be encountered in enhancing, say, some of the intermediate-weight tin isotopes by methods other than the electromagnetic method.

All other major methods of isotope separation which have been put on a practical basis (diffusion; thermal diffusion; electrolysis and fractional distillation; and chemical exchange) depend by contrast on the development of plant in which the enhancement per stage is small but the number of stages is large. Some of the methods have limited versatility; methods of diffusion and thermal diffusion, for example, are generally applicable to elements which have gaseous compounds and few isotopes. In general, however, a special method has to be worked out for each element: chemical exchange for nitrogen, fractional distillation for carbon (as carbon monoxide), thermal diffusion for helium, etc. Once these plants have been set up and developed, however, the running costs are very much less than the costs of producing parallel quantities by electromagnetic separation. Boron, for example, can be separated by electromagnetic methods; but the beam currents are not high, even compared with other elements, in the electromagnetic process, and the costs per gram are very large compared with boron enriched by other methods.

## Enhancements

For most applications of separated isotopes, the degree of enhancement (or enrichment) is the most important factor of the separation process. For a two-component system, we define $C$, the concentration, as the fraction of the isotope compared with the element as a whole; and the isotope ratio as $C/(1-C)$. Then if $C_0$ is the initial concentration, and $C_1$ the final, the degree of enhancement is defined as the ratio of the isotope ratios after and before enrichment, that is

$$\left(\frac{C_1}{1-C_1}\right) \cdot \left(\frac{1-C_0}{C_0}\right).$$

Thus, an isotope of initial concentration 10 per cent enriched by a factor 500 has a final concentration of 98·2 per cent; an isotope of natural concentration 1 per cent enriched by a factor of 100 has a final concentration of 50 per cent. For a multicomponent system (several elements have eight isotopes), such a definition is obviously over-simplified; the accurate description of the enriched sample can only be given in terms of a complete isotopic analysis. However, the enrichment factor, defined above, is still a useful criterion of the quality of the product.

In the electromagnetic separations at Harwell and Oakridge, the enhancements are not infinite, and the products are better described as enriched rather than separated. The enhancements for isotopes of large relative mass separation (lithium-6 and -7) are rather more than 1,000; but if the relative mass separation is small, the enhancements are considerably less, and, while they vary widely from element to element, are usually in the range 20–200. There are several reasons for this: they are all bound up with the fact that one is trying to get quantity separation at high resolution, and in general a compromise must be made. On the whole, however, quality counts for more than quantity, and it is better to reduce output in favour of improved enhancement.

Since the enhancement of the average isotope is not infinite, it might be asked why methods of re-cycling once-separated isotopes cannot be employed. This might be reasonably possible with the isotopes naturally most abundant, where the quantities collected can run to the order of tens of grams. The demand for high enrichment, however, usually applies to the rarer isotopes; and the quantities of these available when initially separated are usually insufficient for re-cycling—or, more precisely, the demand does not justify the effort involved.

## Applications of Separated Isotopes

The availability of separated isotopes has opened up many lines of study, the chief of which may be summarized under the following headings.

*Nuclear physics.* The chief applications of separated isotopes are in nuclear physics. Of the various properties of the individual nucleus, the charge, determining the chemistry of the element, is only one; the spin, the electric quadrupole moment of the nucleus, the energy levels, etc., will vary from isotope to isotope of any given element. For the lighter elements, of course, which have relatively few isotopes, a qualitative picture can be built up without separated isotopes, but a complete analysis of individual properties is difficult. With separated or enriched isotopes, however, the properties of individual nuclei can be studied without difficulty; and, since for most of these studies only small quantities are required, the relatively low output of the electromagnetic plant, as compared with other separation processes, is not a serious limitation.

A good illustration is the example of boron. As noted above, boron enriched in boron-10 is widely used as a neutron detector, having five times the sensitivity as a detector containing the same quantity of natural element. The quantities required are relatively large, and would prove very costly to provide by electromagnetic methods. For studies of the nuclear properties of boron, however, films of only some 100 μgm. per sq. cm. are adequate; and, as boron is deposited from the electromagnetic beam without sputtering, targets can readily be prepared for nuclear analysis. The latter property is a fortunate accident, since boron is an active element at high temperatures, and the preparation of boron films by evaporation is difficult. Films made in this way at Harwell have been used in several studies, including the $(\alpha\gamma)$ correlation in the reaction $^{10}B(n,\alpha)^7Li$ [2], the $Q$-value of the $^{10}B(p,\alpha)$ [4] reaction, nuclear-levels determined in $B(d,n)$ [5] and $B(p,\gamma)$ [6] reactions, and so on. The example of boron has been singled out, but it could be amplified by many references to work on nuclear reactions with isotopes of light or intermediate mass. For those elements which have as many as ten isotopes, it would appear that accurate quantitative work will normally be impossible without highly enriched isotopes.

Enriched isotopes are sometimes used in the study of reactions where it is important not only to eliminate competing reactions but also to concentrate a relatively rare isotope. For example, the quantity of lithium salt which can be loaded into a photographic plate is limited; so that, by using lithium enriched in lithium-6 (natural abundance 7 per cent) the study of a reaction such as $^6Li(\gamma,n)^6Li$ is considerably facilitated[7]. Similarly, in recent accurate work on the $Q$-values of reactions in light nuclei, the use of enriched isotopes magnesium-25 and 26, silicon-29 and 30 (natural abundances 10, 11, 4·7 and 3 per cent respectively) has enabled the intensity to be maintained with thin targets, and the accuracy of experiment thereby held the same as for the abundant isotopes[8].

As regards overall surveys of the properties of nuclides, a study has recently been published of the neutron scattering due to individual isotopes[9]. When the scattering amplitude is plotted against atomic weight, a curve showing quasi-resonance effects is obtained.

Another interesting field for the application of concentrated rare isotopes is the study of weak natural radioactivities. Thus, the products of Oakridge have been used to establish that the natural radioactivity of indium is due to indium-115 [10]; that the natural alpha-activity of samarium is due to samarium-147 [11]; and have promoted several studies in potassium-40 by enriching it from the natural concentration of 0·01 to 7 per cent[12].

*Spectroscopic work.* Various types of spectroscopic study can be carried out with the aid of enriched isotopes. There are several examples of rare isotopes of odd atomic weight, the study of the hyperfine structure and spin properties of which has been made difficult by the presence of their much more abundant neighbours of even atomic weight. By using the separated rare isotope, the Copenhagen group has studied the hyperfine structure properties of neon-21 and krypton-83 [13]. As regards the even atomic weight isotopes, the availability of enriched isotopes makes possible a detailed study and survey of the little explored phenomenon of isotope shift. Finally, the concentration of individual even isotopes makes possible the availability of better standard wave-length light sources. Thus, mercury and cadmium have been widely used as wave-length standards: mercury has seven isotopes and cadmium eight, so that in both there is broadening of the lines by isotope shift due to the even isotopes and (generally) hyperfine structure for the odd isotopes. Mercury-198 formed by pile irradiation of gold has been for some time used as a light source free from these

defects; but other even isotopes (mercury-202) have recently been separated[14], as a more abundant supply, and krypton-84 has been used for similar purposes[15].

*Medical applications.* The high cost of separation makes stable isotopes too expensive an item for most medical experiments; one application, however, is a promising exception. Natural iron (iron-54, 56, 57 and 58), when irradiated in a pile, produces radioactive iron-55 and 59. Iron-59 has a half-life (46 days) which makes it suitable as a tracer in experiments with human beings; iron-55, while satisfactory for general biological experiments, has a half-life (four years) which makes it a hazard in experiments on humans. Attempts to obtain iron-59 from pile-irradiated cobalt have proved difficult, owing to the high concentration of cobalt-60. If, however, one forms a 'source' of iron-58, from which the exclusion of iron-54 by electromagnetic separation is easy, then the iron-59 produced by pile irradiation can be extracted by a Szilard–Chalmers process, and the bulk of the iron-58, by repeated irradiation, is eventually converted to iron-59. In this way an adequate supply of suitable radioactive iron is made possible.

*Superconductivity.* Isotopic effects are usually confined to nuclear interactions, but a recent discovery by Serin, Reynolds and Nesbitt[16] has shown a variation in the superconductive transition temperature of mercury with variation in mean isotopic mass. This effect has been confirmed in Britain and in America[17] by using the separated isotopes of tin, and the theoretical prediction, $T \times m^{1/2} = \text{constant}$, has been approximately confirmed. The British results suggest that possibly the exponent of the mass factor is slightly less than $\frac{1}{2}$.


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# OBITUARIES

## Dr. Yoshio Nishina

THE death occurred on January 10, at the age of sixty, of Dr. Yoshio Nishina, president of the Scientific Research Institute, Ltd. By his death, the Japanese scientific world lost an eminent leader.

Dr. Nishina was born on December 6, 1890. Graduating from Tokyo Imperial University in 1918, he entered the Institute of Physical and Chemical Research. In 1921 he went to Europe to study at the Cavendish Laboratory, Cambridge, under Lord Rutherford, then at the University of Göttingen, and later at Copenhagen under Prof. N. Bohr. While working in Copenhagen during 1923–27, he published several important papers, such as "Study on *L*-series X-ray Absorption Spectra of the Elements from Sn to W", "Study on the Effect of Chemical Combination upon X-ray Spectra", and "Study on Quantitative Chemical Analysis by X-ray Spectroscopic Method". Collaborating with Dr. O. Klein, he calculated the scattering cross-section of hard X-rays by a free electron and deduced the well-known Klein–Nishina formula in 1928. In November 1928, he returned to the Institute of Physical and Chemical Research by way of the United States and initiated the pioneer work in the fields of cosmic rays and nuclear physics in Japan.

In 1937 Nishina constructed a 27-in. cyclotron to pursue nuclear research. One of his investigations in this field was to assign the elements ruthenium, rhodium, palladium, silver, cadmium, indium, tin and antimony to fission products of uranium and thorium. He showed that uranium-237 is produced from uranium-238 and uranium Y from thorium-232 by the $(n, 2n)$ reaction. The mechanism of metabolism of plants and animals was studied, using radiosodium and radiophosphorus as tracer. In 1944 a 60-in. cyclotron was constructed by which 18-MeV. deuterons could be produced. Nishina flew to Hiroshima and Nagasaki to investigate the effects of the atomic bombs just after the explosion in 1945.

He was also interested in cosmic ray research. He measured the intensity of cosmic rays in 1944 in the Shimizu Tunnel at a depth equivalent to 1,400 m. of water. The continuous measurement of cosmic ray intensity which is still being carried on was started by him in 1935.

Theoretical physics in Japan also owes much to his leadership.

Dr. Nishina was appointed as the first president when the Institute of Physical and Chemical Research was reorganized as the Science Research Institute, Ltd., in 1948. In 1949 and 1950 he visited Copenhagen and the United States as a representative of the Japan Science Council. As president of the Scientific Research Institute, Ltd., as vice-president of the Japan Science Council and as president of the Japan Federation of Unesco Cooperative Associations, his activities were many and varied.

His death is a great loss not only for the rehabilitation of science and technology in Japan but also for her progress in general. KENJIRO KIMURA

## Sir Frank Lindley, C.B.

SIR FRANK LINDLEY, who died at Ditchling on August 15 at the age of seventy, spent practically the whole of his working life in the service of the Patent Office, of which he was comptroller-general from December 1932 to September 1944.

He was educated at Brighton Science School and graduated with an honours degree in physics at University College, London. After entering the Patent Office in 1903 he studied law and also found time to take part in student activities at Birkbeck College. When reading for the Bar he was elected Barstow Law Scholar, took a University scholarship in the LL.B. examination, and became a King Edward VII research scholar of the Middle Temple. He became a senior examiner in the Patent Office in 1922, transferred to the Trade Marks side as assistant comptroller in 1926, and succeeded Sir William Jarratt as Comptroller-General of Patents, Designs, and Trade Marks in 1932.

The earlier period of Sir Frank's comptrollership was dominated by the dual tasks of administering the recently passed Patents Act of 1932, which

extended the official search for novelty of inventions to general literature, and taking a very active part in the reform of the Trade Marks law which resulted in the passing of the Trade Marks Act of 1938. The later period was dominated by administration of the Patent Office in war-time when, in spite of bomb and fire damage and much devastation, the work of the Office was carried on continuously. During this period he worked unsparingly at settling the terms of licences for working enemy-owned patents and copyrights, and in dealing with emergency legislation in all branches of Patent Office work. After retiring from the Patent Office he acted for two years as scientific adviser to the Appointments Department of the Ministry of Labour and National Service, in spite of failing health. He endured the progress of Parkinson's disease with conspicuous courage and was bravely upheld by Lady Lindley, whom he first met at Birkbeck College and who survives him with a son and daughter.

# NEWS and VIEWS

## Dr. Elizabeth A. Fraser

With the departure of Dr. E. A. Fraser, the Department of Zoology at University College, London, loses its member of the longest standing. When she joined the Department as a student in 1905 it was headed by E. A. Minchin; but it was under his successor J. P. Hill that she began those original studies in vertebrate development which have been her chief scientific interest ever since. This work has, among other things, contributed much to our understanding of the evolutionary morphology of the excretory organ of the vertebrates, and has provided the basis of our knowledge of the segmental structures of the marsupial head. All her work shows the accuracy and care in minute observation that is an important part of the heritage of classical embryology. With this she combines an appreciation at once sympathetic and critical of the schools of experimental morphology that has served as an admirable stimulus to her many students. Past students of the Department have, indeed, much to thank her for. Whether as assistant, senior lecturer, reader, acting head of the Department (during its war-time evacuation), or since the War as an honorary research associate, she has followed their progress with helpful interest and has never spared herself in their service.

## John Kidd, F.R.S. (1775–1851)

John Kidd, who died a century ago on September 17, 1851, studied medicine at Guy's Hospital, London, and in 1801, after graduating, was appointed reader in chemistry in the University of Oxford. He held the Aldrichian professorship of chemistry from 1803 until 1822, when, through the influence of his former teacher, Sir Astley Cooper, he became regius professor of medicine. He was also physician to the Radcliffe Infirmary and, though he had a large private practice, found time for chemical, geological and mineralogical pursuits. He published "The Outlines of Mineralogy" in 1809 and enriched the Ashmolean Museum's collection of geological specimens. A Fellow of the Royal Society, Kidd's contributions to the *Philosophical Transactions* included an "Essay on the Spontaneous Production of Salt-Petre" (1815) and a paper on "The Anatomy of the Mole-cricket" (1825). Elected keeper of the Radcliffe Library in 1834, he supervised the compilation of the section on medicine and natural history of its catalogue. His Bridgewater treatise "On the Adaptation of External Nature to the Physical Condition of Man" (1837) reached its sixth edition in 1852. Kidd's dislike of ostentation led him to abandon the wig, large hat and gold-headed cane, beloved of his medical colleagues at that time.

## Nuffield Foundation Grant for Research at King's College, London

It is announced by the University of London that the Court of the University has accepted a grant of £10,000 from the Nuffield Foundation for research in biophysics in King's College under the direction of Prof. J. T. Randall, Wheatstone professor of physics. The grant is available over a period of three years and makes provision for a number of fellowships. The present work of the Laboratory, already supported by the Medical Research Council and the Rockefeller Foundation, is to be extended so as to develop the use of electronic devices in conjunction with ultra-violet and infra-red radiations in the study of cells and the structure of biologically important molecules.

## *Laboratoires*: Bilingual Review of French Technology

A new quarterly review in French and English, *Laboratoires* (No. 1, April–June, 1951; pp. 56; Paris: Laboratoires, 11 rue Tronchet; 400 francs or 1500 francs a year), is devoted to French scientific instruments and technical developments. As Prof. G. Yvon explains in the foreword, the aim of the review is to present an accurate picture of research and technical activities in France to-day, and in this way to enable the world to appreciate more fully the work done by French men of science, technologists and industrialists. The first number contains seven articles by leading French scientific workers and technologists. The first, by L. de Broglie, is a discussion of the position of science in general culture, and this is followed by a description by L. Binet of two series of experiments which serve to illustrate the importance of the use of fish in the study of antitoxins. A condensed version of the first part, dealing with precision in metallurgy, of P. Chevenard's important address on January 15 to the members of the Société des Ingénieurs civils de France is given in the third article. "The Engineer and Technical Research" is discussed by M. Roy, a leading French aeronautical authority; and in an illustrated paper on French optics, by P. Fleury, director of the Institut d'Optique, Paris, the development of optical science and of the optical industry in France is outlined. Finally, the number concludes with two interesting articles: one on the influence of the electrical and electronic industries on the evolution of scientific research, by M. Ponte, director-general of the Compagnie Général de T.S.F.; and the other on calculating machines and human thought, by V. Zelbstein, president of the French association of electronic engineers, in which he maintains that many of the ideas involved in cybernetics date back to Descartes, Pascal and

others. The English and French versions of the text are printed in parallel columns. The English translation is on the whole good; but there are, however, several peculiar phrases, mis spellings and too-literal translations.

## Activities of the Department of Scientific and Industrial Research

THE Department of Scientific and Industrial Research has issued a "Brief Guide to the Research Activities of the D.S.I.R. and the Research Associations", in which, following an alphabetical list of the research associations and research stations of the Department, research activities are listed by subject according to the Universal Decimal Classification, with an entry indicating the organization or station where the research in question is proceeding. An alphabetical index of the U.D.C. numbers used is supplied. This first attempt to group the activities of the Department according to the subjects concerned helps to fill in the picture of scientific research in Great Britain which was given in the "Notes on Current Scientific Researches" prepared for the Royal Society Empire Scientific Conference in 1948, and which will be supplemented later this year by a companion volume "Scientific Research in British Universities" now in preparation. Copies of the present publication are being made available on request to libraries, research organizations, university departments and industrial organizations (D.S.I.R., 5–11 Regent's Street, London, S.W.1).

## Artificial Rock for Display Purposes

IN the July issue of the *Museums Journal*, Mr W. T. Stirling, of the Royal Scottish Museum, Edinburgh, describes two methods of making artificial rocks. One of these is applicable to large exhibits and is built up in sections. After roughly arranging the specimens in position, a permanent wooden framework is constructed. This can be covered with tinned sheet iron of 0·005 gauge. When the structure has assumed the desired shape, which in all cases should be based on a photograph of a natural scene, the tin is covered with irregularly torn pieces of brown paper. These are soaked in hot water—for softened in this way they accommodate themselves readily to the required shape—and then fixed with a mixture of equal parts of flour-paste and thin glue. Smaller exhibits can be constructed in peat, and fine detail obtained easily with the use of a penknife. Loose fibres are singed with a gas flame and the charred surface brushed clean. At this point the two methods coincide, and the prepared rockwork receives a coating of thin plaster made by mixing one part of glue in five parts of boiling water and stirring in plaster of Paris until the mixture is of the consistency of cream. This is applied warm, and well brushed into the rockwork. It is advisable to apply a final coating of a thicker mixture of the above ingredients, or preferably of papier mâché. The rock should then be coloured, paying particular attention to detail.

## Dunsink Observatory: Work during 1950

DR. H. A. BRÜCK, director of Dunsink Observatory, gives a short account of the work of the Observatory during 1950 in the June issue of the *Irish Astronomical Journal* (1, No. 6; 1951). The chief instrument, the solar installation, has been completed, and the large concave-grating spectroscope has been mounted in its double-walled box the internal temperature of which will be controlled by a thermostat. New photoelectric photometers for the 12-in. refractor and the 15-in. reflector, involving the use of photomultiplier tubes, have been constructed. The reflector, with a photomultiplier photoelectric photometer, the output of which is recorded by an oscilloscope, has been used for precision measurement of the time of lunar occultations, and an occultation can be timed with an accuracy of a hundredth of a second by this method.

## Royal Anthropological Institute: Annual Report

THE annual report of the Royal Anthropological Institute is more heartening than has been the case for some years. Finance is still the major worry; but this will ease when the Institute with certain other selected learned societies is housed in the new science centre to be built in London. On January 1 this year *Man* achieved its golden jubilee—a notable achievement for any learned journal. The Institute has decided to set up a blood-group centre as part of its work. Collation and synthesis can probably be best served by such an organization run in association with anthropologists. The library of the Institute has been largely transformed, thanks to a grant of 5,000 dollars from the Viking Fund. The fellowship of the Institute is mounting slowly; but, considering the services rendered, it is surprising that the number of Fellows is not greater.

## Manchester Public Libraries: Annual Report for 1949–50

THE ninety-eighth annual report of the Manchester Public Libraries Committee for the year ended March 31, 1950 (pp. 40+4 plates; Manchester: Central Library, 1950), records a reduction in the combined issues of all departments, despite an increase in the use of the reference libraries. The reduction is most marked in the circulation of fiction; within the limits of the present book fund it has been impossible to replace many thousands of volumes withdrawn after very heavy use during and after the War years, and this is regarded as the basic factor in the reduction of total issues from 6,537,939 volumes to 6,124,747, thus interrupting the continuous increase of recent years. While issues in the Reference Library increased by some 3·5 per cent, issues in the Technical Library decreased by 5·5 per cent in spite of an increase of 6·5 per cent in the number of readers using the Library. The demand for more advanced technical books seems to follow supply; libraries which are able to maintain a good range of such works all report that good use is made of them. Stress is laid on the inadequacy of the seating accommodation in the General Reference Library, which is often monopolized by students, while the staff are fully occupied in the routine of providing books for readers and have little time to assist those unfamiliar with the Library or requiring expert assistance. Records of issues in the Technical Library show a transfer of interest from the sciences to the useful arts, and calls on the Technical Library's resources by local firms urgently needing special articles or books increased by 72 per cent.

## Nottingham Research Discussions on Engineering Technology

A SERIES of research discussions on various branches of engineering technology, which is being arranged by the Departments of Civil and Mechanical Engineering of the University of Nottingham, will be held at

the University during October 1951–May 1952. The meetings will consist of lectures and discussions on topics on which research is being carried out at the University, and the object of the series is to facilitate co-operation between the University and industry. The subjects, which will be discussed on consecutive Wednesday afternoons (2.30–4.30 p.m.) between the dates as shown, are as follows: dynamic properties of metals (October 17–31), fatigue of metals (November 21–December 12), structural analysis and the use of models (January 16–30), use of analogies in fluid mechanics (February 13–20), photoelasticity (March 5–19), and dynamic properties of rubber (April 23–May 7). Admission to the meetings is free. Enrolment forms and further details can be obtained from the Registrar of the University, University Park, Nottingham.

## Use of Solid Carbon Dioxide in preparing a Cold Bath

L. G. E. Bell, Department of Zoology, King's College, Strand, London, W.C.2, writes: "Making up a cooling bath by adding solid carbon dioxide to industrial methylated spirit often involves considerable frothing of the spirit unless the addition is made very slowly. I have found that a few drops of a light paraffin sprinkled on the surface of such a bath reduces this frothing very considerably. Three or four drops of cigarette-lighter fuel are sufficient to control a surface of thirty inches square and enable a rapid addition of solid carbon dioxide to be made."

## Announcements

With the retirement of Prof. H. Hartridge in May last, the Vision Research Unit of the Medical Research Council has been re-formed as the Group for Research in the Physiology of Vision, under the directorship of Dr. L. C. Thomson. The scope of the work undertaken by the members of the new Group is essentially similar to that of the Vision Research Unit, and the address remains the same, namely, Institute of Ophthalmology (University of London), Judd Street, London, W.C.1.

The Royal Society of Arts has awarded the R. B. Bennett Empire Prize for 1951 to Mr. E. Bruce Levy, director of the Grasslands Research Division of the New Zealand Department of Scientific and Industrial Research, for his work on grassland farming. This Prize, which is worth 100 guineas, was endowed in 1944 by the late Lord Bennett and is awarded every three years for the most outstanding contribution from the Dominions and Colonies of the British Commonwealth to the promotion of the arts, agriculture, industries or commerce.

Prof. N. F. Astbury, professor of applied physics in the New South Wales University of Technology, has been appointed to the chair of physics at the Gordon Memorial College, Khartoum.

The National Conference of the Institute of Personnel Management, which includes the annual general meeting of the Institute, will be held at the Royal Hotel, Harrogate, during October 5–7, the theme being "Personnel Management and Productivity". The Conference will begin at 8.30 p.m. on October 5, and prior to this on the same day a one-day course on "Personnel Management" will be held in the Lounge Hall, Royal Baths, Harrogate. Further details of both meetings can be obtained from the Institute at Management House, Hill Street, London, W.1.

A symposium on the corrosion of buried metals, organized by the Iron and Steel Institute in conjunction with the British Iron and Steel Research Association and the Corrosion Group of the Society of Chemical Industry, will be held at the offices of the Iron and Steel Institute, at 4 Grosvenor Gardens, London, S.W.1, during December 12, with Sir Charles Goodeve, director of the British Iron and Steel Research Association, in the chair. The symposium will be open to all, free of charge. Admission tickets (application to be made before October 13) and further details can be obtained from the secretary of the Institute at the above address.

A second conference on coastal engineering, sponsored by the Southwest Research Institute, San Antonio, Texas, in co-operation with the University of California, Texas A. and M. Research Foundation, Rice Institute, University of Houston and the American Society of Civil Engineers (Houston Branch), will be held at the Rice Hotel, Houston, Texas, during November 7–10. The major topics to be discussed will be the fundamentals of wave action, development of basic design data, natural and artificial movement of sediment, site criteria for harbours and other coastal works, design and construction of structures exposed to wave action, and the biological impact of marine structures. Further information can be obtained from the conference secretary, Charles E. Balleisen, c/o Southwest Research Institute, 8500 Culebra Road, San Antonio 6, Texas.

The Chemical–Biological Coordination Center of the National Research Council is organizing the second Symposium on Chemical–Biological Correlation, to be held at the National Academy of Sciences in Washington, D.C., during October 24–25, 1952, and it is intended to include in the programme one or several scientific films which deal specifically with the effect of chemicals upon biological systems, such as organisms, organs, tissues, cells, etc. Any information about the availability of such films should be sent to the Center at 2101 Constitution Avenue, Washington, D.C.

The second International Congress of Biochemistry will be held in Paris during July 21–27, 1952. The programme has been provisionally arranged in seven sections, as follows: biochemistry of steroids, biochemistry of hæmatopoiesis, biogenesis of proteins, tricarboxylic acid cycles, bacterial metabolism, mechanism of action of antibiotics, protein hormones and hormones derived from proteins. Communications dealing with other biochemical problems will be grouped together in further appropriate sections. Those intending to read papers should send in the titles before March 1, 1952, and a summary of less than two hundred words before April 1, 1952, to the general secretary of the Congress, Prof. J. E. Courtois, 4 Avenue de l'Observatoire, Paris 6e.

The Board of Greenkeeping Research has recently been registered as a public company limited by guarantee under the provisions of the Companies Act, 1948, and will henceforth be known as the Sports Turf Research Institute. The new Institute remains as previously a non-commercial, non-profit-making organization and will maintain the work of the old Board as a research, advisory and educational body in problems of turf (see *Nature*, **166**, 22; 1950). The headquarters will continue to be at the St. Ives Research Station, Bingley, Yorkshire.

# PROBLEMS OF MARGINAL LAND FARMING

By SIR PATRICK LAIRD, C.B.
Secretary, Department of Agriculture for Scotland

UNDER this title a subject which has attracted much attention in recent years was discussed at the Edinburgh meeting of the British Association in a joint session of Sections F (Economics) and M (Agriculture) at which I had been invited to preside. Before vacating the chair, the president of Section M (Dr. E. M. Crowther) opened the proceedings by posing a question as to the precise meaning of the title. None of the speakers, however, gave an unequivocal answer to Dr. Crowther's question. Indeed, it was pointed out that when it had come to drafting legislation designed to give assistance to marginal land farmers for the rehabilitation of their holdings, nobody would venture to use the phrase marginal land at all; it became 'livestock-rearing land'.

All the papers read and the contributions to the debate did, in fact, accept that the main problems involved are those of the farmers (mostly small farmers) in the upland areas the main productive function of which is the rearing of store cattle and sheep. The chairman pointed out that there are at least three aspects of the problems involved: first, that of the technical agricultural difficulties in the management and improvement of land and stock; secondly, that of the economic and sociological factors affecting the welfare and prosperity of this sector of agriculture; and thirdly, that of the wider economic justification, or otherwise, of devoting national resources to food production on the less fertile land of Great Britain. It is at least arguable that the country would need to use to the utmost both the better and the poorer land.

Prof. W. Ellison, of Aberystwyth, gave a most interesting analysis, based on surveys and investigations in England and Wales and Scotland, of the probable costs involved in the rehabilitation of land and equipment in the upland areas, and of the increased returns which might be expected after the improvements had been carried out. Broadly, it appeared that costs working out at about £32·5 per acre could, over a period of years, be almost exactly recovered in higher returns. In Prof. Ellison's view this would not be attractive without the present subsidies (for liming, drainage, hill cattle, etc.) *plus* the 50 per cent grants for rehabilitation schemes now available under the Livestock Rearing Act, 1951. The money available under this Act, it was pointed out, would probably enable at least one million acres (out of some 3·75 million 'improvable' acres in Great Britain) to be rehabilitated. It was estimated that more than 50 per cent of all improvement expenditure would be on equipment, that is, rehabilitation of the holding rather than improvement of the land.

If *all* the improvable livestock-rearing land could be dealt with on these lines, Prof. Ellison concluded, additional output could be obtained equivalent to between 350,000 and 400,000 store cattle, providing when fattened an extra 100,000 tons of meat. This is rather more than a third of the meat imported from Argentine in 1949 and a little less than Australian supplies.

Mr. O. J. Beilby, advisory officer on agricultural economics in the Scottish Department, emphasized at the outset that while the agriculturist thinks of marginal land as being 'land on the margin of cultivation', the economist thinks in terms of the margin of profitability, and therefore of the farm rather than of the land. He pointed out that it has been roughly estimated that there are some 45,000 stock-rearing farms in Great Britain. They account for about 12 per cent of the acreage of all crops and grass, and support some 23 per cent of the sheep and 12 per cent of the cattle in the country. A sample of 122 such farms in Scotland has shown that cattle account for 24 per cent of the output, sheep 29 per cent, crops 26 per cent and poultry and eggs 15 per cent.

Nearly 60 per cent of stock-rearing farms in Scotland are rented at less than £50 per annum. The sample showed an average net income of £488 per annum (including £272 from subsidies). It appears that if the thirteen larger farms in the sample were excluded, the figure would be only £366 (including £220 of subsidies !).

The basic problem, according to Mr. Beilby, is to increase the earning capacity of the farm unit, by increased size of farm, or greater intensity of production. The former method would reduce the number of farmers: it would therefore raise problems of rural depopulation and, by leading to a more *extensive* system of farming, it might well be inconsistent with the needs of the country for maximum food production.

The sociological problems thus touched on by Mr. Beilby were followed up by Dr. Joseph Duncan in the third paper of the morning. The conditions in which marginal land farming is commonly found—such as high altitude, inherently poor soil, exposed situation, short growing-season, distance from markets—do not make it attractive to farmers with capital, and it is carried on usually with the aid of family labour by small men accustomed to a frugal standard of living. The more enterprising tend to leave such areas, and in the past hundred years there has been in many districts a marked depopulation trend. In such conditions the quality of the social life is bound to deteriorate. The community "tends to become a closed one and to lose variety. A shrinking community sheds its tradesmen and its functionaries".

Very many of the farmers on upland farms do not now earn as much as do wage earners on the lowland farms, and because of this and the social isolation there is a constant drain away of young people, who have, thanks to improved transport, discovered that there are more attractive places in which to live and work.

More capital and larger farms seem to Dr. Duncan to be the best solution of the economic problem, though as an alternative upland farms might be taken over by lowland farmers and run in conjunction with lowland farms. Neither method would, however, ease the social problem; and to ensure the kind of community which would solve that problem, it seemed to Dr. Duncan that forestry is essential; there is no good reason why farming and forestry should be regarded as competitive, and on the social side, forests offer more hope of a re-integration of community life in the uplands than anything else.

In opening the general discussion, Mr. A. R. Wannop, technical development officer in the Scottish Department, stressed the importance of maintaining the necessary interdependence of lowlands and uplands as regards both cattle and sheep. He

thought we should be careful not to over-capitalize the upland farms, and pointed out that expenditure on the scale suggested by Prof. Ellison might add £2–£3 per cwt. to the cost of production of a weaned suckled calf. There is great need, he said, for a new building technique to cheapen the costs of rehabilitation. A self-feeding pit silo, as used in America, would be a boon. Above all, greater attention should be given to advisory work, directed more to the economy of the whole farm than to details of land improvement.

Mr. Phillips Price and Mr. Gorrie (Ceylon) took up and supported Dr. Duncan's plea for afforestation. As Mr. Price pointed out, Nature abhors continuous cropping, and lack of balance is just as detrimental in the case of livestock as in cultivation. Mr. Gorrie spoke of the benefits derived from the shelter belts established in the eighteenth century, and suggested that progress in the upland areas is dependent on the supply of labour and machinery.

Three or four farmers, from both sides of the Border, made useful contributions to the debate, in which varying views were expressed as to the economics of the business. Mr. J. A. Symon, formerly chief inspector of the Scottish Department, thought that too much attention is paid to that aspect and referred to the go-ahead enterprise of some farmers in the reclamation of land in Orkney and elsewhere.

Perhaps the question still remains: What exactly is marginal land? I am tempted to quote from a delightful little 'essay' written in the early 'forties by a member of a war-time executive committee in the Border country:

"Marginal land was discovered by the Farmers' Union in 1940. Prior to that date there was none of it: to-day there is little else but. The Department, later, recognized its existence. They have regretted their action ever since. Nobody quite knows where it is except the man who farms it. But Members should be suspicious of any land situated near a margin. Such land is almost certain to be marginal land.

"Sub-marginal land is found under marginal land. Sub-soil is not the same thing. Super-marginal land was also discovered on the same day by the same explorer. All land situated above marginal land is super-marginal. These sub and super discoveries should greatly simplify the work of Members."

However, this member and his colleagues, and those of other executive committees in Scotland, have done a good and conscientious job during the past eight years in the administration of the Marginal Agricultural Production Scheme. There are undoubtedly long-term problems still to be solved, but at least these upland farmers, contributing some 10 per cent of the total agricultural output of the country, have been enabled with State assistance to keep going and to make a reasonable contribution to the nation's food supplies.

## HIGHER TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

At a discussion on higher technological education on August 13 before Section L (Education) at the British Association meeting at Edinburgh, over which Sir Hector Hetherington presided, Mr. H. J. Cull gave a well-balanced and concise review of the technical colleges and their development and an appreciation of the contribution they could make in this field. He claimed that higher technological work is a natural part of the development of these institutions, as is indicated by the growth and success of their work in providing courses for Ordinary and Higher National Certificates and for external University of London degrees, as well as, in the larger colleges, for general science degrees, special science degrees and engineering degrees. A technological course of degree standard is a natural development if the needs of industry are to be met, and such a course should include more fundamental science than is usual in National Certificate and diploma courses, and more applied science and technology than finds a place in the external degree syllabuses. If liaison with industry is maintained and developed, the colleges consider that they could provide courses which, with the freedom of an internal examining system, could well be different from the external degree.

Mr. Cull emphasized here that periods of full-time study would be necessary, but that with the co-operation and goodwill of industry there should be no major problem in planning the association of study with experience as a vital part of the course. On the question of the award to be received by the successful student, Mr. Cull indicated the alternative proposals, but urged that early decision is imperative and that any award should carry national recognition. Post-graduate training, he thought, would present less formidable problems if such schemes were allowed to develop, and particularly if the postgraduate courses were developed in association with neighbouring universities. Here, particularly, questions of accommodation and of staff, in his opinion, are important, and equipment and apparatus are expensive items; on the staff side, quality is as important as numbers, and to obtain staff of the requisite quality with real experience of industry and its needs is not easy. He thought that, if properly used, the scales of the recent Burnham report give scope for such appointments to be made. Solution of the problems of accommodation of staff would, moreover, permit the gradual establishment of real centres of research, with teams of research workers, including staff and students, and possibly, in some problems, some workers on a part-time basis from industry. Many of the problems investigated might conceivably come from industry itself, and just as some industrial firms find themselves touching the field of fundamental science, so some investigations in the technical colleges might be concerned with direct industrial problems.

Mr. Cull recognized that not every technical college could or should be called on to provide higher technological courses, and that some regional planning would be necessary. He recognized, too, the critical importance of finance, though he passed over the question of local administration in relation to the academic freedom of the teacher and investigator. He was confident, however, that the technical colleges could provide not only the technicians but also the technologists needed in Great Britain, and that there is in the colleges the enthusiasm to do this work once it is given direction and the student the necessary incentive.

Prof. J. C. Prescott, dealing with the university aspect of the problem, distinguished at the outset between two schools of thought: one regards higher technological courses as providing an opportunity of treating specific advances in technology; the other advocates courses in which the emphasis is upon fundamentals and in which recent technological developments appear as illustrations of the more

general theory. In the universities, the mode of study is to approach the particular example by way of the most general principle, to consider specific phenomena in terms of, and by the light of, fundamental theory. This method is in general followed in their schools of applied science, and accordingly, Prof. Prescott suggested, universities could provide the proper environment only for the second type of course. If they attempted to do more they would forsake their legitimate function.

Prof. Prescott pointed out in passing that the rapid advances in technology have created teaching difficulties for the universities, where reorganization to allow greater attention being given to the study of the fundamental sciences has left less time available for the study of their application in technology. Nevertheless, he thought that university courses which first of all establish the fundamental principles upon which technology is created and then show their application by examples selected from among modern developments would provide a satisfactory solution. While a better medium of education from the point of view of technology, they could not be so comprehensive as regards new advances as the courses which they replace. Advanced courses in technology should be regarded by the universities as the natural continuation of their undergraduate courses. Even here, however, the university should be circumspect and insist that the courses approach the particular through the general, and seek to educate rather than to instruct. He did not believe that a university could usefully conduct courses containing little more than an isolated description of recent developments in technology.

Prof. Prescott said that the results of postgraduate courses of the type he advocated, so far as he has seen them, have been excellent. He thought there is no evidence that the courses have had any narrowing effect, because a systematic study of the sciences involved is as essential as their informed and logical application in the technology. Moreover, the increasingly sympathetic understanding of the engineer's outlook by the scientific worker, strengthened by the latter's growing reliance on the engineer for the design of special apparatus, has largely dissipated fears that such courses might turn promising engineers into indifferent physicists or chemists. Indeed, this clear understanding between the engineer and the scientific worker is fostering happier relations between pure and applied science departments in the universities. Higher technological education, in fact, offers the universities, and particularly their faculties of applied science, a great opportunity of giving systematic education to an advanced standard in subjects which in the past they have only been able to treat sporadically, or at a comparatively elementary level.

Neither of these papers gave any attention to the quantitative aspect of the question, on which clearly a decision as to where the expansion of facilities for higher technological education should take place must partly depend; nor did the ensuing discussion, which was opened by Sir Arthur Fleming, give any clearer lead there, or as to the desirability of any new award. Sir Arthur, commenting on industry's need for the technologist as well as the technician, observed that the number of corporate members of the great engineering institutions who have qualified through National Certificate courses is about the same as the number from university degrees. He endorsed what had been said as to the necessity of teaching of the highest order and the value of postgraduate courses, but added that the chief anxiety in recruitment is as to whether we are securing men of the right type for industry. Sir Arthur urged that the personal qualities of courage, powers of decision, judgment, leadership and the ability to mix well with others should count as much or more than technical or scientific ability. These personal qualities are formed before the young men reach industry, and he knew of firms which for this reason are turning to the public schools, because the technical knowledge could be imparted.

The importance of personal qualities was equally stressed by Wing-Comdr. T. R. Cave-Browne-Cave, who commented that the same qualities of leadership and decision which the Fighting Services seek are needed in industry. The syllabuses of courses should not be so full as to require a concentration on academic work which hinders the development of personal qualities. He thought, too, that it is important for higher technological education to develop independently of the universities, and that the technical colleges should not depend on the universities for their higher award.

The discussion, on the whole, was disappointing in that, although attention was directed to the main factors on which the expansion of technological education in Great Britain turns, no clear lead was given as to their relative importance or the form in which that expansion should immediately proceed. The need for early decision was rightly stressed; but even in the emphasis on the importance of personal qualities, no suggestions were advanced as to whether these would be better fostered in the universities or in the technical colleges. Sir Arthur Fleming's suggestion regarding travelling fellowships relates to the postgraduate stage and the acquiring of the experience and outlook required to fill the highest positions in industry.

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# CATALYTIC CONVERSION OF A DIENE INTO DEEPLY COLOURED POLYENES

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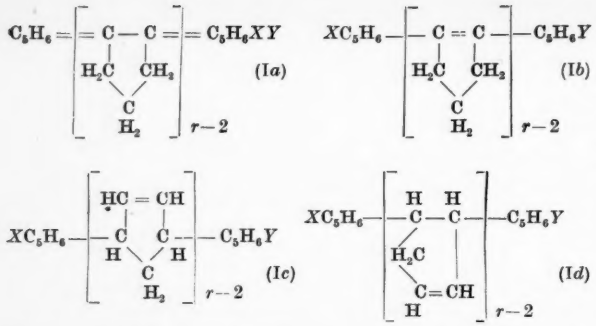
*PROPERTIES indicating the presence of conjugated double bonds.* *Cyclo*pentadiene can be converted catalytically into a deep red poly*cyclo*pentadiene-trichloroacetic acid adduct (I), the yield under suitable conditions being more than 90 per cent of the theoretical amount. Analyses, molecular weight determinations and fractional precipitation tests make it probable that a mixture of polymer homologues, of composition $(C_5H_6)_r(XY)$ and a number average degree of polymerization $r = 18 \pm 2$, is formed, $(XY)$ being here and later the symbol for trichloroacetic acid. The unsaturated nature of (I) is shown by its large consumption of potassium permanganate, under relatively mild conditions; and the interaction with molecular oxygen, ozone, nitric acid, perbenzoic acid and hydrogen, in presence of



(Ia) (Ib) (Ic) (Id)

platinum oxide, proves that there is one double bond in each *cyclo*pentadiene unit. The deep red colour of the chromatographically purified substance (I), the formation of deeply coloured blue molecular compounds with strong acids, or antimony trichloride, and their decomposition by proton acceptors is compatible with (Ia) or (Ib) rather than with (Ic) or (Id)[1].

The supposition that this polymerization involves a migration of hydrogen atoms with formation of conjugated double bonds is supported by the fact that compound (I) is capable of forming an addition product with maleic anhydride and by its infra-red absorption spectrum in the range of the double-bond vibrations. It has been observed, moreover, that on addition of dry trichloroacetic acid to a solution of compound (I) in carefully dried benzene, with the formation of a dark blue molecular compound, the specific conductivity (which at a given concentration of (I) is approximately proportional to the trichloroacetic acid concentration) shows a marked increase; this indicates salt formation, due to the transfer of a proton to the molecule containing the conjugated double bond[2].

In dilute solution, each *cyclo*pentadiene unit of (I) consumes two bromine atoms. A polymer of composition $(C_5H_6Br_2)_r(XY)$ could not be isolated, however, because hydrogen bromide is lost with great ease and a stable derivative is formed the approximate formula of which is $(C_5H_6Br)_r(XY)$. This product is deep red, like (I); this is probably due to the re-formation of some conjugated double bonds.

*Light absorption.* Long-chain conjugated polyenes are known to be characterized by sharp absorption bands in the near ultra-violet and visible region[3]. In contrast to this, a band structure in the spectrum of (I) could only be observed between 2500 A. and 2800 A., while in the range 2800–10,000 A. the extinction coefficients decrease continuously; and there are also no bands due to electronic transitions between 10,000 A. and 30,000 A. Account must, however, be taken of the fact that (I) is a mixture of homologues, not an individual conjugated polyene, and it is reasonable to assume that the lack of bands at wave-lengths larger than 2800 A. is due to the fact that the light absorption of the individual components is modified by optical superposition. This hypothesis is supported by the results of experiments (to be described elsewhere) dealing with the light absorption of artificially prepared mixtures of authentic polyenes, containing respectively four, six, eight and ten conjugated double bonds.

*Kinetic measurements.* These show that the conversion of *cyclo*pentadiene into compound (I) is a chain polymerization involving intermediates of short life-time, and that the course of the reaction can be adequately represented by three elementary steps, namely, initiation, propagation and termination; so far, no indications of chain transfer or marked effects due to traces of water have been observed. The initial rate of the monomer consumption in carbon tetrachloride solution is proportional respectively to the first power and to the square of the *cyclo*pentadiene and trichloroacetic acid concentrations; and the number average degree of polymerization does not depend on the initial concentration of the reactants or on the degree of conversion, up to 80 per cent reaction. These observations can be interpreted by the following initiation reaction involving the trichloroacetic acid - catalysed addition of trichloroacetic acid to *cyclo*pentadiene, and by a termination stage in which the growing polymer reacts with monomer:

$$C_5H_6 + 2(XY) \rightarrow C_5H_6(XY) + (XY).$$

It has previously been found[4] that the rate of the trichloroacetic acid - catalysed dimerization of *cyclo*pentadiene is proportional to the first power of the trichloroacetic acid concentration. If, therefore, the catalyst concentration is sufficiently low, the formation of compound (I) is completely overshadowed by the dimerization reaction. Proton acceptors inhibit both the polymerization process and the catalysed reaction leading to the dimeride[4], and it is probable, therefore, that both processes involve ionic intermediates. It is recognized, however, that the mode of linkage of the *cyclo*pentadiene units in di*cyclo*pentadiene and in compound (I) is fundamentally different, the former substance being the product of a 1 : 4–1 : 2-addition[5], which does not involve the migration of hydrogen atoms.

*The end group.* It is known from previous investigations[6] that trichloroacetic acid adds readily to isolated or conjugated double bonds to form esters. By analogy, it is probable that the initiation reaction already indicated also leads to an ester and that, therefore, the end groups $X$ and $Y$ in compound (I) are respectively $Cl_3CCOO$ and H, rather than $Cl_2CCOOH$ and Cl. This conclusion is in concordance with results of experiments showing that compound (I) is not capable of forming pyridinium, potassium, sodium, calcium, barium, copper or silver salts: and it is proved by the fact that alkaline hydrolysis of (I) gives rise to the formation of alkali trichloroacetate (identified by conversion into the benzyl*iso*thiourea salt), and of a chlorine-free polymer without liberation of chloride ions. If, on the other hand, compound (I) contained a free carboxyl group, the removal of chlorine from the polymer by alkaline hydrolysis would liberate three equivalents of chloride.

*Colloid chemical effects.* Solutions of compound (I) in benzene are strongly associated; this follows from a comparison of cryoscopic and end-group molecular weight determinations. If the benzene or carbon tetrachloride solution is shaken with aqueous solutions of salts, acids or bases, stable and remarkably viscous emulsions are formed.

A detailed account of this work and the results of similar experiments dealing with other molecular compounds, halogenoacetic acids and dienes will be

published elsewhere. We are grateful to Drs. H. Steiner and E. T. Borrows for discussions, to Dr. A. Elliott for some of the infra-red absorption measurements, and Dr. Rubin and Mr. Street for experimental assistance.

[1] Staudinger and Brusson, *Annalen*, **447**, 103, 110 (1926), and Carmondy, Sheehan and Kelly, *Indust. Eng. Chem.*, **30**, 245 (1938), prepared poly*cyclo*pentadienes and suggested repeating units as in (Ic) or (Id); it is possible that some of the poly*cyclo*pentadienes described in the recent patent literature are also built up according to this latter structural principle; cf., for example, Soddy, U.S.A. Patent, 2319271.

[2] Cf. Weiss, *J. Chem. Soc.*, 245 (1942).

[3] Hausser, Kuhn and Smakula, *Z. phys. Chem.*, (B), **23**, 384 (1935). Karrer and Jucker, "Carotinoide" (Basle, 1948). Blout and Fields, *J. Amer. Chem. Soc.*, **70**, 189 (1948).

[4] Rubin, Steiner and Wassermann, *J. Chem. Soc.*, 3046 (1949).

[5] Alder and Stein, *Annalen*, **504**, 216 (1933).

[6] Nernst and Hohmann, *Z. phys. Chem.*, **11**, 352 (1893). Clark, Ph.D. thesis, University of Missouri (1937). Wassermann (unpublished experiments).

# PAPER CHROMATOGRAPHY OF MUSCLE TISSUE CONSTITUENTS

## Paper Chromatography of Adenosine Phosphates

CARTER[1] has devised a method for paper chromatography of adenosine phosphates. He uses as solvent a 5 per cent dibasic sodium phosphate solution and *iso*-amyl alcohol. For developing the spots after drying, he sprays the paper with fluorescein and localizes the spots with an ultra-violet lamp ('Mineralight').

We have modified the partition coefficient between the two phases by using a solution of 0·5 per cent lauryl amine in *n*-amyl alcohol instead of *iso*-amyl alcohol. The resolution of the spots has much improved by this method. We believe that this method can be adapted to other substances; thus, for substances of basic character laurylic acid can be used to improve the resolution.

We have compared our method with the original method of Carter on adenosine phosphates. With Carter's method, using an adenylic acid preparation (Merck), two spots were obtained with $R_F$ 0·73 and $R_F$ 0·66, and, according to Carter, who obtained identical results, identified as the adenosine-2-phosphate and adenosine-3-phosphate. Besides these substances, a smaller spot due to inosinic acid was visible. Adenosine diphosphate obtained by splitting adenosine triphosphate with myosin gave a longer spot, which sometimes seemed to consist of two spots of $R_F$ 0·80 and 0·75. Adenosine triphosphate from muscle gave only one spot ($R_F$ = 0·82), but often this was somewhat extended.

Using our method, we obtained the following components from the adenylic acid preparation, which tentatively have been identified as follows:

| Substance | $R_F$ |
|---|---|
| Inosinic acid | 0·86 |
| Adenosine-2-phosphate | 0·69 |
| Adenosine-3-phosphate | 0·61 |
| Adenosine | 0·48 |

The component with $R_F$ 0·69 has the same $R_F$-value as adenosine-5-phosphate, which can be obtained from muscle adenosine triphosphate by cautious hydrolysis or prolonged storage. The components have been identified from the discussions given by Carter[1] and Kornberg[2].

Adenosine diphosphate here clearly showed two spots with $R_F$ 0·76 and 0·69 respectively. The first one is due to the diphosphate; the other one is adenosine-5-phosphate, probably obtained through a small contamination of the myosin by myokinase.

Even adenosine triphosphate from muscle gave two spots, $R_F$ 0·83 and 0·76. The first one is due to the triphosphate, the other to the diphosphate. Adenosine triphosphate is apparently very often contaminated with adenosine diphosphate owing to the instability of the triphosphate.

Our examples show that the modification of the partition coefficient with lauryl amine in amyl alcohol very much facilitates the resolution of the different derivatives of adenosine phosphates, and is superior to Carter's original method.

OLLE SNELLMAN
BERTIL GELOTTE

[1] Carter, C. E., *J. Amer. Chem. Soc.*, **72**, 1466 (1950).
[2] Kornberg, A., and Pricer, jun., W. E., *J. Biol. Chem.*, **186**, 557 (1950).

## A Phosphate-absorbing Protein from Muscular Tissue

IN connexion with the preparation of myosin from cardiac muscle[1], a protein containing a nucleotide has been isolated. This protein seems to be firmly bound to the actomyosin complex. However, it is freed to a certain extent when the complex is dissociated into myosin and actin. Only by treatment with organic solvents has it been possible to separate the protein from undissociated actomyosin.

The interesting feature of this substance is its ability to absorb the phosphoric acid residue, which is split from adenosine triphosphate by the enzymatic action of myosin.

The protein is not myosin. It more resembles actin, but it is not an actin in the usual sense. It does not polymerize and does not combine with myosin as actin does.

The present communication records an attempt to analyse the prosthetic group of the protein. This has been done mainly with the aid of paper chromatography and measurements of the ultra-violet absorption spectra in a Beckman spectrophotometer. The absorption curves have a maximum at 260 mμ in neutral and alkaline solutions. In acid solutions a maximum at 263 mμ is obtained, and here also the curve becomes asymmetric. This is different from that of adenylic compounds. Chromatographic measurements[2] by the method described elsewhere show that the preparations contain not more than two components, or sometimes only one. In the system 5 per cent dibasic sodium phosphate – 0·5 per cent lauryl amine in amyl alcohol, it gives an $R_F$ value of 0·67. In some cases a double spot is obtained with $R_F$ 0·63 and 0·67.

After hydrolysis (0·1 *M* hydrochloric acid, 30 min. at 100° C.) two components appear in the chromatograms. One of these, with $R_F$ 0·40, is identical with adenine, while the other, with $R_F$ 0·85, has not yet been identified. This component seems to be some pyridine or pyrimidine derivative with basic properties. A prolonged hydrolysis causes no changes in this component, and furthermore the chromatographed substance is soluble in acids only. Milder hydrolysis (alkaline hydrolysis or 0·1 *M* hydrochloric acid, 5 min. at 100° C.) gives, in addition to the two spots of $R_F$ 0·40 and $R_F$ 0·85, two other spots with $R_F$ 0·57 and $R_F$ 0·68. The former of these may be adenosine-3-phosphate and the latter probably adenosine-5-phosphate. The component with $R_F$ 0·68

may also be unhydrolysed nucleotide. Extraction of the spots and identification by ultra-violet absorption measurements has not been successful, since the amyl alcohol used in the chromatography is contaminated by a substance with absorption in this region. Purification of the amyl alcohol has been unsuccessful, and it has not yet been possible to get a synthesized amyl alcohol.

These investigations show that the prosthetic group is a dinucleotide. Kornberg[3] has shown that diphosphopyridine nucleotide (co-zymase, co-enzyme I) can undergo a direct phosphorylation to triphosphopyridine nucleotide (co-enzyme II) by adenosine triphosphate and a yeast enzyme. Since the dinucleotide described here has the same characteristic, one may suppose an analogous structure. However, it does not seem to contain nicotinic amide but another as yet unidentified substance with basic properties.

Further investigations are going on, and a more detailed description will appear elsewhere.

The investigation is being supported financially by the Swedish Natural Science Research Council.

Bertil Gelotte

[1] Gelotte, B., *Biochim. Biophys. Acta* (in the press).
[2] Snellman, O., and Gelotte, B. (see preceding communications).
[3] Kornberg, A., *J. Biol. Chem.*, **182**, 805 (1950).

## The Prosthetic Group of Actin

A study of the prosthetic group of *G*-actin and *F*-actin has been made with paper chromatography, using as solvent an aqueous solution of 5 per cent dibasic sodium phosphate and a solution of 0·5 per cent lauryl amine in amyl alcohol as described elsewhere[1]. We could detect only one spot when investigating the prosthetic group of *F*-actin, the $R_F$ value of which was 0·67. From *G*-actin also only one spot was visible, with the $R_F$ value 0·64. These $R_F$ values correspond to the values found for the phosphate-absorbing protein derived from the actomyosin complex reported in another communication[2]. Acid hydrolysis of the prosthetic groups from the two kinds of actin showed, upon paper chromatography, identical spots with the $R_F$ values 0·40 and 0·85 respectively. The prosthetic group of actin is a dinucleotide containing adenosine and another hitherto unidentified base. This dinucleotide can occur in two forms, one richer in phosphorus (in *G*-actin) and the other poorer in phosphorus (in *F*-actin). It may be mentioned that in no circumstances have any spots derived from adenosine tri- or di-phosphate been detected. The $R_F$ values for these substances under the same conditions are 0·83 and 0·76, so they must occur in insignificant amounts.

Earlier, Straub *et al.*[3] have found that actin contains a prosthetic group which they consider to be adenosine triphosphate in *G*-actin, and which during the polymerization of *G*-actin to *F*-actin splits off one phosphoric acid residue and is transformed into adenosine diphosphate.

The absorption spectrum of the isolated prosthetic group in a Beckman spectrophotometer gives a curve which resembles that of an adenosine derivative. The relation of the absorption curve to *p*H, however, is different from that of an adenosine phosphoric acid. It seems also that the prosthetic group can in certain circumstances be split, giving off adenosine-5-phosphate, which can be deaminated by Schmidt's deaminase. These results have supported the incorrect assumption that the prosthetic group is adenosine triphosphate instead of the dinucleotide.

*G*-actin contains the dinucleotide which is rich in phosphorus, and *F*-actin contains the dinucleotide poorer in phosphorus. During the transformation of *G*-actin into *F*-actin, the phosphorus-rich and therefore more labile dinucleotide gives off one phosphoric acid residue and is transformed into the dinucleotide of *F*-actin.

Upon contraction *in vitro* of actomyosin with adenosine triphosphate, the myosin splits off a phosphoric acid residue of the triphosphate. It is possible for the energy-poor dinucleotide in *F*-actin to take up such a phosphoric acid residue in the nascent state. *F*-actin is thus transformed to *G*-actin during the contraction.

Straub *et al.* have found that when *F*-actin is dialysed against a solution of adenosine triphosphate for a longer time, the *F*-actin is converted into *G*-actin. At the same time adenosine triphosphate disappears and adenosine diphosphate appears. He assumes that the diphosphate in *F*-actin takes the place of triphosphate. From our results the process is better explained by assuming that the dinucleotide takes up a phosphoric acid residue from the adenosine triphosphate on account of its instability; it always loses phosphorus gradually with time. We have also found that the dinucleotide can take up phosphoric acid residues given off by the adenosine triphosphate in such a manner.

It seems thus that adenosine triphosphate does not play the dominant part previously assigned to it in the contraction process. This role may be taken by a dinucleotide (one group of which is adenosine, the other is not yet identified) which can take up and give off a phosphoric acid residue. The adenosine triphosphate acts as a phosphorus donor.

In many respects this dinucleotide resembles cozymase, which also occurs both as a phosphorus-rich and a phosphorus-poor compound (co-enzyme II and I). A comparison of the dinucleotide with cozymase has shown that they are not identical.

Further details of these investigations, which were supported financially by the Swedish Natural Science Research Council, will be given elsewhere.

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Uppsala.
April 25.

[1] Snellman, O., and Gelotte, B. (see preceding communication).
[2] Gelotte, B. (see preceding communication).
[3] Straub, F. B., and Feuer, G., *Biochim. Biophys. Acta*, **4**, 455 (1950).

## CHEMISTRY OF CANCER

A meeting, under the joint auspices of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry, and the Institute of Petroleum, was held in Manchester on March 15, with the general title "The Chemistry of Cell Division". The proceedings were sadly interrupted by the sudden death of Prof. G. A. R. Kon while contributing to the discussion at the end of the morning session, and the meeting was abandoned. Three papers were, however, read.

In his introductory survey, Prof. A. Haddow dealt with the biological effects (tumour-inhibitory, cytological and carcinogenic) of cytotoxic substances, with special reference to the nitrogen mustards. It is

difficult to improve on the activity of *bis*-β-chloroethylamine (HN2), but *bis*(β-chloroethyl) β-naphthylamine (R.48) has certain advantages and its clinical effects were discussed in some detail. In the case of cancer-producing compounds earlier studied, there is still no knowledge of their exact site of action in the cell. However, the carcinogenic nitrogen mustards, first investigated as potential war gases, and related compounds appear to act directly on the chromosome structure and in so doing bring about effects in many ways indistinguishable from those due to X-rays.

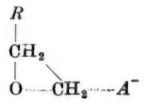
Tumours induced by injection or feeding of these compounds have cytological abnormalities which persist through many generations of transplantation in certain tumours, but which, in other tumours, vanish after a few transplantations. While these observed cytological effects are almost certainly not those primarily responsible for the induction of cancer, they can be regarded as associated phenomena. Chemical features of the nitrogen mustards have suggested the examination of related types of compound such as ethylene oxides and imines, which are of interest on account of their capacity for chemically cross-linking textile fibres and which have been shown to produce similar cytological effects. All these types are believed to react by a carbonium-ion mechanism with reactive centres in protein and nucleo-protein. From studies of the action of such compounds on chromosome organization, Prof. Haddow suggested that the production of cancer in these cases is due first of all to their chemical combination with hereditary material in the cell, and secondly to resultant change in chemical and genetic properties expressing itself as alterations in growth behaviour.

Dr. W. C. J. Ross then delivered a paper entitled "Cytotoxic Action in Relation to Chemical Reactivity" in which he elaborated the carbonium-ion reaction mechanism of radiomimetic cytotoxic compounds. These compounds include sulphur and nitrogen mustards, methylolamides, epoxides, ethyleneimines and some sulphonic esters. All these types can be regarded chemically as alkylating agents.

In the case of the β-chloroethylamines, the carbonium ion is produced either by elimination of the chlorine atom as chloride ion under the electron-repelling influence of the nitrogen atom, or alternatively via the cyclic ethyleneimonium ion, which, though reasonably stable in aliphatic mustards, would not be expected to be stable in aromatic analogues. In the case of the ethylene oxides and imines and the sulphonic esters, the reaction is bimolecular, the ion having no separate existence. Thus, for example, the reaction of an ethylene oxide ring with an active centre involves the displacement of the oxygen atom from the reacting carbon atom with the formation of the transition complex (I).

The ease with which various groups react with carbonium ions has been investigated in detail, and in protein the most reactive centres are the ionized carboxyl group followed by terminal and histidine amino groups; in nucleic acids the reaction occurs preferentially with phosphoryl and aromatic-type amino groups. No reaction takes place, at physiological *p*H, with aliphatic hydroxyl groups.

Dr. Ross showed the influence of structure on the activity of the mustard type of compound by an examination of a series of *bis*-(β-chloroethyl) anilines. If electron-repelling groups are introduced into the nucleus, separation of the chlorine atoms as ions is facilitated, reactivity, as measured by rate of hydrolysis in aqueous acetone, is increased, and so is tumour-inhibitory activity. Electron-attracting groups have the converse effect. Similarly, replacement of the chlorine atoms by bromine or iodine, or introduction of β-methyl groups into the chloro compound, leads to enhanced activity in certain weakly active substances. Increasing the separation between active centres in this type of molecule seems to lead to decrease in biological activity, though chemical reactivity is not appreciably affected.

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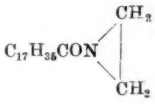


II

In presenting his paper entitled "Cytotoxic Action in Relation to Molecular Shape", Dr. F. L. Rose dealt with the role taken by the whole molecule of the cytotoxic agent (as distinct from the formation of chemically reactive centres discussed by Dr. Ross). He showed that not only may the methylolamides, epoxides and ethyleneimines react with cell components, but, in addition, as they are all groupings which are known to lead to polymer formation, polymeric molecules may be the ultimate units which react in the cell. The nitrogen mustards can be regarded as a special case of the ethyleneimines, and a linear polymer with quaternized nitrogen atoms is a possibility.

As a corollary it follows that the activity of certain other cytotoxic agents such as the polycyclic hydrocarbons and the dimethylaminoazobenzenes and stilbenes can be explained on a similar basis, by supposing that the 'polymer' units are made up of micelles or bundles of molecules held together by residual valency forces, each individual molecule being linked by conjugation to cell protein. Certain dyestuffs containing azobenzene or stilbene nuclei are known to have micelle-forming properties, and the large flat polycyclic hydrocarbons may well behave similarly.

This hypothesis has been tested by preparing and examining a long-chain aliphatic hydrocarbon molecule which carries a group capable of reacting with protein and which by virtue of its long chain also forms micelles. This compound, stearoyl ethyleneimine (II), shows cytotoxic action and is a potent carcinogen.

In his introduction to the discussion, Prof. Kon stressed the satisfactory correlation between cytotoxic activity and the degree of purely chemical reactivity of the nitrogen mustards as measured by hydrolysis-rates. On the question whether the effect of chain-length can be attributed to steric or to polar factors, the answer seemed to him to be fairly clear, namely, that the two ends of the chain can be separated within limits, but that if the distance of the terminal carbon atom from the nitrogen atom is much increased beyond two carbon atoms, the activity falls off sharply, as does the rate of hydrolysis. If, however, this separation is achieved by inserting $CH_2$-groups between two nitrogen atoms so placed as to exert their polar effect and favour the production of a carbonium ion, the lengthening of the chain effects but little decrease in biological activity. Prof. Kon said that he had every hope from all this work of eventual results with a very positive bearing on the cancer problem as a whole.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Localization of Bacterial Nucleic Acids and Mechanism of the Gram Reaction

As a consequence of the brilliant studies of Stacey and co-workers, reviewed by Webb[1], many investigators of the Gram reaction in bacteria are agreed that the Gram complex is a combination of basic dye and pentose nucleoprotein, apparently localized at or in the cell wall. However, as Lison[2] has pointed out, the problem of localization in cytochemistry is a difficult one, and it is not altogether certain that the basophilic component of the Gram complex normally occurs at the cell wall.

The site of production of pentose nucleotides has an obvious bearing upon the problem of localization of the Gram complex. From their study of both Gram-positive and Gram-negative bacteria, Malmgren and Hedén[3] concluded that bacteria have two nucleotide-forming systems, one of pentose and the other of deoxypentose type, which form a functional unit but are located in separate organelles within the cell.

Our own studies of fusobacteria, clostridia and lactobacilli indicate that the two structures concerned with nucleotide production form a single morphological unit. But regardless of which view is correct, it becomes evident that the presence of pentose nucleoprotein at the bacterial cell wall represents secondary localization. We have attempted to determine whether this secondary localization is the result of a normal physiological process or an artefact produced by the Gram-staining procedure itself.

Young lactobacilli in smear preparations were stained rapidly with dilute basic dye. Large basophilic polar areas were thus revealed, but there were no basophilic areas adjacent to the cytoplasmic membrane as in the Gram reaction. Gram-stained cells decolorized with acid alcohol and restained with dilute basic dye had diffusely distributed basophilia. When the iodine 'mordant' was omitted in this last experiment, the original distribution of basophilia in simply-stained cells was found. It was concluded, therefore, that the iodine solution is responsible for shifting basophilia from the polar areas to the cell wall.

To test this, a series of preparations were stained with Stirling's gentian violet solution, and then placed in an iodine – potassium iodide solution of *p*H 9·1. Slides were withdrawn at intervals and the Gram staining completed. After 15 min. exposure to the iodine solution, the lactobacilli were Gram-positive, after 30 min. Gram-negative, with Gram-positive polar zones, and after 45 min. again completely Gram-positive. Further treatment failed to effect another reversal of the Gram reaction.

By varying the hydrogen ion concentration, as well as the potassium iodide, it was found possible to influence the speed at which the Gram-negative phase appeared. As the hydrogen ion concentration increased, the time required to reach the Gram-negative phase also increased, while an increase in potassium iodide concentration accelerated the appearance of the Gram-negative phase. It was concluded that there are two basophilic components in lactobacilli which give the Gram reaction; one component is relatively quickly mobilized and can be extracted with iodine solution, whereas the other is only slowly mobilized and cannot be extracted with iodine. Since both basophilic components were hydrolysed by Kunitz-type ribonuclease or $N/1$ hydrochloric acid, it is possible they are pentose nucleoproteins.

The second pentose nucleoprotein component was found as a cortex to nucleal-positive (deoxypentose nucleic acid) polar granules. It differed significantly from the other, since it retained gentian violet staining when the cells were subjected to decolorization without prior iodine treatment.

A less detailed study of *Clostridium septicum* gave results essentially the same as those obtained with lactobacilli.

It is evident that the iodine treatment in the Gram-staining procedure is a complex process involving at least three effects upon various pentose nucleoprotein fractions in the bacterial cell, namely, increased strength of dye binding, alteration of position, and extraction.

The mechanism by which iodine increases dye binding has not yet been elucidated. According to Stearn and Stearn[4], it is due to a greater lowering in the isoelectric point of a protoplasmic component in the Gram-positive organisms than in the Gram-negative. Although no data are on hand to settle the point, a difference in tyrosine content between the pentose nucleoproteins of the Gram-positive and Gram-negative forms could account for such a mechanism, since the iodination of tyrosine increases its acidity[5]. We therefore have reason for suspecting that tyrosine may play an important part in the functioning of cytoplasmic nucleoproteins, and it is of interest to note that Bradfield[6] has postulated that since peptidases do not attack peptides containing phosphotyrosine, it may be possible that combination of tyrosine groups with nucleic acid phosphate might be a means of preventing peptidases from splitting protein during the synthesis of the latter.

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## Alkaline Phosphatase and Contractile Proteins

Alkaline phosphomonoesterase is usually defined as an enzyme with a *p*H optimum around 9·5 which splits monoesters of phosphoric acid. Relatively recently it was found that the comparable acid phosphatase can act as a phosphokinase (Axelrod[1]), and afterwards Meyerhoff[2] showed that alkaline phosphatase also may act as a phosphokinase. The characteristic action of a phosphokinase is the ability to catalyse the transfer of phosphate from one organic molecule to another.

Cytochemical studies have shown that alkaline phosphatase exists characteristically on chromosomes[3], newly formed collagen[4] and at the secretory border of a wide variety of secretory cells[5]. Studies by Rothstein and Meier[6] and Brown[7] have shown that enzymes, including phosphatase, are present even on the external surface of cells. Wilbrandt and Rosenberg[8] have shown that phosphatase is closely associated with the secretory transfer of molecules across cell membranes. Whereas individual theories have been advanced in attempts to explain the association of alkaline phosphatase with individual items of this variety of cytological sites and functions, the explanations as a group have lacked unity. But a unity of pattern emerges immediately if it is assumed that in all cases we are concerned with *contractile proteins*.

It is now well established that the contractility of the protein myosin is closely associated with adenosinetriphosphatase activity. The general theory which is now advanced is that in all the phenomena mentioned in the previous paragraph a not greatly dissimilar contractile protein and phosphatase activity are concerned.

Goldacre[9] has advanced an elegant theory, in which he suggests that amœboid movement and secretion may both be accomplished by contractile proteins. If his theory were correct, contractile proteins would be required at the surfaces of cells, and particularly at those cellular surface sites at which alkaline phosphatase has been discovered by cytochemical methods. It may now be suggested that the function of the alkaline phosphatase at these sites is not simply to hydrolyse phosphate esters, as has hitherto been supposed, but to provide the focal points for release of the energy required for protein contraction and extension. In some cases the whole energy of hydrolysis of a phosphate bond may be required for the process of transfer, so that for each molecule transferred across the cell membrane an orthophosphate ion will appear. But it would be much more economical of energy, and is therefore intrinsically more probable, that for the most part the enzyme acts, not as a phosphatase, but as a phosphokinase, transferring a phosphate group from a high-energy bonding, as in adenosinetriphosphate, to a lower-energy bonding. In such a process the difference in energy between the two bondings would be available for the protein contraction : the transferred phosphate group may appear on the transferred molecule, giving the transfer the overall character of a trans phosphorylation.

Chromosomes are known to contract to a very marked degree in mitosis and meiosis. Phosphatase is commonly present on meiotic and mitotic chromosomes : it is now suggested that the phosphatase represents a key enzymic centre of a contractile protein system which is responsible for the contraction of chromosomes. It is notable that phosphatase is also commonly found in the chromocentres of intermitotic nuclei, which are probably regions of persistent, or perhaps intermittent, chromosome contraction : here also, phosphatase may be an integral part of the contractile protein of the chromosome.

A similar view may be taken of the phosphatase of newly formed collagen. One of the most striking features of the healing of a wound is the contraction which occurs as collagen is laid down. The collagen at the time of contraction is rich in phosphatase, and it is now suggested that collagen is fundamentally a contractile protein and that the phosphatase represents the enzymically active centres concerned either in contraction or in extension. When collagen contraction is complete, there is no further requirement of contractile energy, and it is thus not surprising that mature collagen contains little phosphatase. In vitamin C-deficient guinea pigs, although much protein is formed in healing wounds, it lacks phosphatase, and, as is required by the present theory, no contraction occurs.

Thus all the facts available at the present time are compatible with the view that many of the phosphatases found in animal cells are integral parts of contractile proteins. To separate the enzyme from cells it is often necessary to resort to drastic procedures, including partial autolysis. Thus the soluble phosphatases of the biochemist (for example, kidney phosphatase) often are likely to be, in the strict sense, artefacts.

It is well known that the biological function of a molecule depends upon the nature of the colloids in its environment. Thus when hæm is associated with different proteins, one obtains hæmoglobins of various types, cytochromes, cytochrome oxidases, catalases or peroxidases, according to the natures of the proteins. Further, even with an established type of enzyme activity, the specific degree of activity may vary notably when different supernumerary colloids are in the environment. Keilin and Mann[10] have shown this is the case with carbonic anhydrase, and Keilin and Hartree[11] have observed this phenomenon with succinic dehydrogenase. Consequently, when we consider purified isolated phosphatase, it must be remembered that the protein of the enzyme may well be much modified from that originally present in the cell, and that the remaining enzyme activity may be a very poor guide to the function of the enzyme in the cell. We may even speculate whether the co-existence inside cells of phosphatases and phosphate esters is not made possible by the so-called phosphatases having little or no phosphatase activity when in their correct cellular environment.

With these points in mind, it seems advisable to regard all purified enzymes as at least partial artefacts, until the contrary has been demonstrated.

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## Histamine Release by Anaphylatoxin

Early studies of the mechanism of anaphylaxis led to two apparently contradictory views : the so-called 'humoral theory', according to which the blood is the site of production of a toxin, the anaphylatoxin[1–4]; and the 'cellular theory', which localizes the anaphylactic reaction in the cells, and assumes

that this reaction causes the release of histamine from the tissues[5,6]. The anaphylatoxin theory was based on the finding that guinea pig serum treated with the specific precipitate or with kaolin, barium sulphate, agar, starch or inulin, becomes toxic for the guinea pig and, if injected intravenously, produces symptoms indistinguishable from true anaphylaxis.

The finding by various authors[7,8] that contact of the antigen with washed, perfused lungs of the guinea pig in the absence of blood is sufficient to release histamine led to the general acceptance of the cellular theory and completely obscured the humoral theory. However, in other species, such as the rabbit and the dog, the blood is known to participate in the anaphylactic reaction of histamine liberation[9]. Evidence that the blood, when activated, contains a powerful agent for the release of histamine was first presented by one of us in experiments in which the dog's liver was either perfused with Tyrode solution or with blood. It was known[10,11] that, *in vivo*, enormous quantities of histamine, amounting to milligrams, are released from the dog's liver during anaphylactic and peptone shock. On the other hand, the release of histamine by antigen or peptone from a dog's liver perfused with Tyrode solution amounted to a few micrograms only. If, however, whole blood was used for the perfusion, and particularly if the blood was collected without any anticoagulant in flasks covered with silicone, an entirely different result was obtained. When peptone was added to such blood, which was then pumped through the liver, as much as 8 mgm. of histamine and 25 mgm. of heparine were released[12]. This finding suggested the existence of a powerful histamine-releasing agent in the blood of the dog. A similar discrepancy concerning the release of histamine from the dog's liver was found by Reid[13] with *d*-tubocurarine when it was either injected intravenously or perfused through the isolated liver.

Recently, Hahn[14] has shown that antihistamine substances are able to prevent the shock which is produced in guinea pigs by an anaphylatoxin prepared from a guinea pig serum incubated with inulin. This observation would suggest that anaphylatoxins also act through histamine release, a possibility which was tested and proved to be true by the following experiments.

The lungs of fifteen guinea pigs were perfused with Tyrode solution at a rate of 15–25 ml. per min. After a few minutes perfusion, 4 ml. of 'activated' guinea pig serum was injected into the cannula and the perfusate assayed for histamine on guinea pig's gut. The histamine values were expressed as base. Activation of the serum was by incubation with 0·2 ml./ml. of an agar suspension prepared according to Bordet[3], the so-called agar-anaphylatoxin.

During the first few minutes after the injection of the activated serum, large amounts of histamine were released from the lungs. In one experiment in which the serum had been dialysed before agar treatment, its injection caused the release of 103 μgm. histamine in the course of 10 min.; the maximal output per minute was 23·2 μgm. In other experiments in which activated serum without previous dialysis was injected, the total outputs ranged from 14·3 to 32·6 μgm. (average 23·5 μgm.) and the maximal outputs per minute from 7·3 to 21·3 μgm. (average 14·5 μgm.). These values have to be contrasted with the few micrograms of histamine released by contact of antigen with washed guinea pig's lungs. In such experiments Bartosch, Feldberg and Nagel[7] obtained between 0·5 and 4 μgm., and Daly, Peat and Schild[8] between 0·17 and 12 μgm. of histamine only.

Heating the serum for 30 min. at 60° C. before the addition of the agar suspension abolished, and at 56° C. reduced, the activating effect of the agar. After activation, somewhat higher temperatures were required. Heating activated serum for 1–2 hr. at 60–65° C. diminished its potency in releasing histamine. For example, in four lungs the average output of histamine after the injections of unheated serum was 23·5 μgm. as compared with the average output of 9·5 μgm. from four other lungs following the injection of heated serum. This difference is significant ($t = 4·5$; $P < 0·02$). After precipitation of the proteins with alcohol at boiling point, or for 15 min. at 65° C., the filtrate, dried *in vacuo* and taken up in 4 ml. water, no longer released histamine from perfused lungs. Dialysis of activated serum did not affect its histamine-releasing property.

The results of these experiments enable us to bridge the two main opposing views concerning the mechanisms underlying anaphylaxis and related phenomena. The presence, in circulating blood, of a powerful histamine-releasing agent which can easily be activated may be of importance not only for anaphylaxis but also for the etiology of a number of other pathological conditions, particularly of allergic phenomena.

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## Thyroxine Therapy in Male Infertility

Very little systematic work has been done on the influence of the administration of thyroxine in physiological doses on male infertility in animals of different ages. This seems to have some practical value in the field of reproductive physiology, as male fertility decreases with advancing age and so does the rate of secretion of thyroxine. The question then arises whether any relationship exists between poor fertility and the decline in the rate of secretion of thyroxine in older animals and, if so, what is the effect of the administration of different doses of thyroxine on the male reproductive processes. In

the present experiment, nine buck rabbits (inbred strains), which were classed as infertile in view of their poor breeding records, were used for studying the effects of the administration of known doses of thyroxine on libido, semen qualities and testis histology.

Two weeks before the start of the experiment and for eight weeks during the period of treatment with thyroxine, semen samples were collected biweekly by means of an artificial vagina. Sexual desire and semen qualities were estimated for the individual bucks. The results suggested that one of the causes of low fertility in the buck rabbits is a decrease in the rate of secretion of thyroxine which occurs with advancing age, because the administration of moderate doses of thyroxine greatly improved the sexual desire and semen qualities and stimulated the process of spermatogenesis in the seminiferous tubules of the testis of the treated rabbits, which before starting the treatment showed poor sexual desire, deterioration in semen qualities and arrested spermatogenesis (Figs. 1 and 2). A number of giant cells were observed in some of the seminiferous tubules of the testes of the untreated infertile buck rabbits (Fig. 2). The formation of these giant cells appears to be associated with arrested spermatogenesis. A peculiar type of sperm abnormality observed in the semen samples collected from these untreated buck rabbits[1] disappeared with thyroxine treatment, evidently due to the marked stimulation of the process of spermatogenesis, which was observed on histological examination of the testes. The younger buck rabbits responded to the thyroxine treatment comparatively better than the older ones.

The poor sexual desire in the untreated buck rabbits seems to have been due to the interference with the production of the male sex hormone by the interstitial cells of the testes, since on histological examination the interstitial cells showed atrophic changes, with a decrease in number and an increase in the intertubular stroma. I found[2,3] that during the non-breeding season in the young ram there occurs a similar marked decline in libido, semen qualities and in the process of spermatogenesis. Administration of thyroxine in physiological doses to young rams during the non-breeding season practically maintained the sexual desire, semen qualities and the process of spermatogenesis at the same level as that estimated during the breeding season. I have discussed elsewhere[4] the mechanism responsible for the seasonal decline in male fertility. Thyroxine therapy greatly improved the libido and fertility-rate of a young Essex boar, which before treatment showed poor libido and a marked decline in the fertility-rate observed during the summer months.

The mechanism whereby the thyroid gland influences the male reproductive processes has already been briefly outlined by me[5], and it has been suggested that there is an interrelation between the thyroid, adrenals and gonads[5,6]. Further, addition of thyroxine in critical concentrations to bull semen samples resulted in an increase in the oxygen uptake of the spermatozoa after storage for 24–44 hr. at + 5° C. *in vitro*[7]. The present results show that the administration of thyroxine in physiological doses considerably improves the libido, semen qualities and the process of spermatogenesis in infertile buck rabbits. Detailed results will be published elsewhere.

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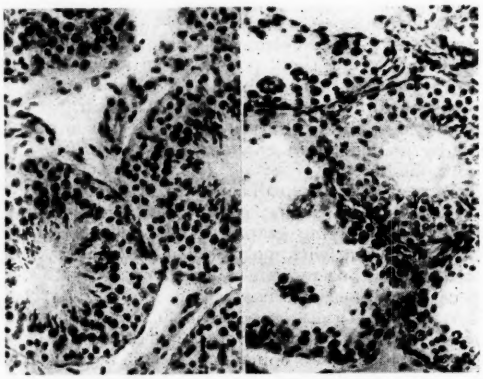
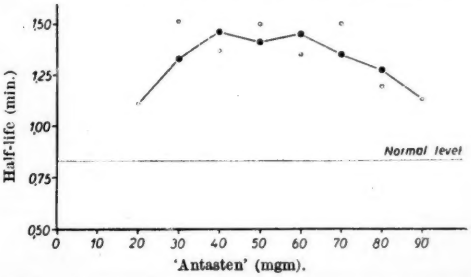


Sections of the testes of infertile buck rabbits: (1) showing arrested spermatogenesis; the lumina of the tubules contain protoplasmic debris; (2) showing atrophic and degenerative changes, with giant cells in the seminiferous tubules. × 200

## Effect of Antihistamine on the Reticulo-endothelial System; Investigation of Reticulo-endothelial Function with the Aid of Radioactive Chromium Phosphate

In 1947, Jancsó[1] put forward the view that histamine is an activator of the reticulo-endothelial system and antihistamine is an inhibitor. Halpern and his co-workers[2] carried out investigations on the subject which supported Jancsó's observations. Biozzi[3] has reported that antihistamines prevented the absorption of indian ink by endothelial cells.

In the investigations here, the influence of antihistamine on the colloid-absorbing ability of the reticulo-epithelial system was examined by means of intravenous injection of a radioactive chromium phosphate suspension (labelled with phosphorus-32).




Biological half-life in the blood of intravenously injected labelled chromium phosphate in rats after subcutaneous treatment with different doses of 'Antasten'. ○, Mean of individual observations (10 animals in each group). ●, Moving mean values

*Method.* The antihistamine used was 'Antasten' (Ciba, Switzerland: 2-phenylbenzylaminomethylimidazol). The colloid-absorbing ability of the reticulo-endothelial system was estimated in two ways:

(*a*) By determining the biological half-life of intravenously injected radioactive chromium phosphate in the blood of animals treated with 'Antasten' and comparison with normal values. This shows the rate at which the reticulo-endothelial system removes the colloid from the blood circulation.

(*b*) By investigating the effect of 'Antasten' treatment on the distribution in the body of the intravenously injected radioactive chromium phosphate[4,5].

All experiments were carried out on white laboratory rats of a body-weight of 140–150 gm. and of both sexes. Eighty rats were injected with different doses of 'Antasten', as was done by Jancsó. Ten rats in each group were injected with 20, 30, 40, 50, 60, 70, 80 and 90 mgm. in two equal portions at 30-min. intervals. Fifteen minutes after the last injection, the reticulo-endothelial system functional test was carried out, and the biological half-life of the radioactive chromium phosphate in the blood was determined.

In the second series, thirty rats were used. Five groups of five animals were treated with different doses of 'Antasten', 20, 40, 60 and 80 mgm., in the same way as in the first series; as a control, five rats were injected with an isotonic saline solution instead of 'Antasten'. Fifteen minutes later, all the animals were injected with the chromium phosphate preparation, and two hours later they were killed and the radioactivity of the different organs was determined.

Table 1. Biological Half-life of Radioactive Chromium Phosphate in the Blood after Subcutaneous Injection of Various Doses of 'Antasten' (Compared with Controls without 'Antasten' Injection)

| Dose of 'Antasten' in mgm. | Biological half-life (min.) | |
|---|---|---|
| | Exp. animals (10 per group) | Control animals (25) |
| 20 | $1{\cdot}11 \pm 0{\cdot}05$<br>$0{\cdot}147$ | |
| 30 | $1{\cdot}51 \pm 0{\cdot}15$<br>$0{\cdot}460$ | |
| 40 | $1{\cdot}37 \pm 0{\cdot}07$<br>$0{\cdot}218$ | |
| 50 | $1{\cdot}50 \pm 0{\cdot}07$<br>$0{\cdot}224$ | $0{\cdot}83 \pm 0{\cdot}05$<br>$0{\cdot}250$ |
| 60 | $1{\cdot}35 \pm 0{\cdot}11$<br>$0{\cdot}334$ | |
| 70 | $1{\cdot}50 \pm 0{\cdot}09$<br>$0{\cdot}293$ | |
| 80 | $1{\cdot}19 \pm 0{\cdot}08$<br>$0{\cdot}266$ | |
| 90 | $1{\cdot}13 \pm 0{\cdot}09$<br>$0{\cdot}271$ | |

$\bar{X} \pm \varepsilon\bar{X}$ = mean of individual observations and its standard error

$\sigma$ = standard deviation of observations

*Results and Discussion.* Table 1 and the accompanying graph show the collected results of the biological half-life determinations in the series of eighty rats. The radioactive colloid circulates longer in the blood after treatment with 'Antasten' than it does in normal animals, and the uptake of the colloid in the reticulo-endothelial system is retarded. The biological half-life is distinctly prolonged after 20 mgm. of 'Antasten' and still further prolonged with 30 mgm. There is no further increase with doses between 30–70 mgm., and with doses of 80 and 90 mgm. the biological half-life approaches the normal value. Table 2 shows the statistical analysis of the results obtained.

Table 2. Difference in Biological Half-life after Various Doses of 'Antasten' (cf. Table 1 and Graph). Analysis of Variance

| Type of variance | Sums of squares | d.f. | Variance | $F$ | $P$ |
|---|---|---|---|---|---|
| Between class | 2·03 | 7 | 0·29 | 3·41 | $0{\cdot}01 < P < 0{\cdot}001$ |
| Within class | 6·08 | 72 | 0·08 | | |
| Total | 8·11 | 79 | | | |

The analysis of variance (Table 2) shows that the variation between the half-life values in the graph could not have arisen at random. Furthermore, the component mean values which constitute the curve differ significantly from the control values, as is obvious on mere inspection of the values in Table 1 and the graph.

In a previous report[5], it was shown that the ratio of distribution of radioactive colloids was constant in normal animals for the liver, spleen and lungs. The control animals injected with an isotonic saline solution exhibited similar amounts of radioactivity in the liver, spleen and lungs as those treated with various doses of 'Antasten'. These experiments have shown that 'Antasten' does not have any particular point of attack in the reticulo-endothelial system.

The results above indicate that 'Antasten' has a significantly inhibitory effect on the rate of colloid absorption in the reticulo-endothelial system; but with the methods employed it was not possible to show any special inhibition of the reticulo-endothelial cells of the liver, spleen or lungs.

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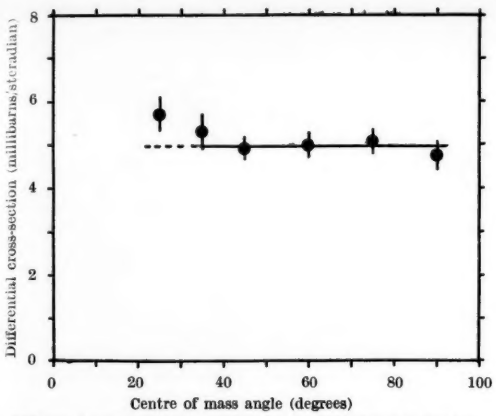
## Proton–Proton Scattering at 146 MeV.

A proton beam has been extracted from the 110-in. Harwell cyclotron by scattering the internal beam at a uranium target[1]. Deflected protons escape from the cyclotron along a path sheltered from the magnetic field by an arrangement of iron bars[2]; but sufficient field remains to separate outgoing protons of different energies. Protons of $147 \pm 1$ MeV., as determined by their corrected[3] range in aluminium, are selected by slits and passed down an evacuated tube 12·7 metres long to a point behind a concrete screening wall. A flux of $2 \times 10^6$ protons-cm.$^{-2}$-sec.$^{-1}$ is available at the end of the tube, and this is monitored by an ionization chamber and an integrating d.c. amplifier.

The external beam has been used first for a study of proton–proton scattering with the results shown in the accompanying graph. The experiment has been carried out with polyethylene scatterers, the effect of the carbon present being subtracted with the help of graphite scatterers.

Relative cross-sections between 35° and 90° were measured by coincidence counting of both the protons involved in each collision. At 35° a very thin scatterer had to be used because the energy of one of the protons is much reduced at small angles of scattering. At 25° only the 'forward' proton could be detected, and the results at this one angle may




Differential cross-section for proton–proton scattering as a function of centre of mass angle. The incident protons had a laboratory energy of 146 ± 1 MeV. The errors shown are statistical standard deviations on the relative measurements at the various angles. The absolute cross-section at 90° has been found to be 4·99 ± 0·31 millibarns-steradian$^{-1}$, and the weighted mean of the points between 35° and 90° has been normalized to this value

have been affected by systematic errors. When only one proton was being counted the carbon effect increased greatly, so that the final result was obtained from a small difference between two much larger counting-rates. The errors given in the graph are the statistical standard deviations on these relative measurements.

The absolute cross-section was obtained through a comparison of the differential proton–proton cross-section at 90° with the cross-section for the $^{12}C(p,pn)^{11}C$ reaction. This reaction was observed by irradiating a clear naphthalene crystal and afterwards examining it with an *E.M.I.* photomultiplier, guard crystals being used to prevent any of the carbon-11 decay positrons from escaping. The efficiency of detection of these positrons during the calibration run was found to be 87·2 ± 1·7 per cent by fitting an integrated Fermi distribution to the bias curve of counting-rate against discriminator voltage. This value for the efficiency was checked by the usual coincidence method, using a sodium iodide crystal to detect annihilation γ-rays. The ratio of the differential proton–proton cross-section at 90° to the $^{12}C(p,pn)^{11}C$ cross-section was found to be 0·0787 ± 0·0031 at an effective energy of 146 ± 1 MeV., allowance being made for the slowing down of the primary protons in the scatterer and crystal. The stated standard deviation is intended to cover likely systematic errors. Adopting[4] 63·4 ± 3·0 millibarns for the $^{12}C(p,pn)^{11}C$ cross-section, the differential proton–proton cross-section at 90° was calculated to be 4·99 ± 0·31 millibarns-steradian$^{-1}$. Since the relative cross-sections between 35° and 90° showed no evidence of anisotropy, the angular distribution measurements were normalized so that the weighted mean of these five points was equal to 4·99 millibarns-steradian$^{-1}$.

Proton–proton scattering at high energies has previously[5–7] been found to be isotropic at 100, 240 and 345 MeV. The absolute magnitude of the cross-section given here is also quite consistent with these three sets of results, but it is rather higher than that found by Chamberlain, Segrè and Wiegand[8] in another series of experiments, in which the external proton beam of the Berkeley cyclotron was slowed down by absorbers. In terms of the theory of Jastrow[9], the higher cross-section suggests that the proposed central repulsion in the proton–proton interaction is at a radius not greater than 0·50 × 10$^{-13}$ cm.

Much of the apparatus used in this experiment was made by Mr. R. A. Gibbons and assembled by Messrs. P. H. Bowen and L. Bird. The proton monitor was supplied by Mr. L. Pittendrigh. The work was greatly assisted by the enthusiastic co-operation of Mr. A. O. Edmunds and the cyclotron crew.

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## Radiocrystallographic Study and Molecular Weight of Actinomycin from *Streptomyces S-67*

The crystals of actinomycin obtained by one of us[1] are prismatic monoclinic needles, with the length parallel to the binary axis. The mean values of the angles between the most frequent faces are:

| | | | |
|---|---|---|---|
| $p(001)$ | : | $h^1(100)$ | 69° 17′ |
| $h^1(100)$ | : | $a^1(10\bar{1})$ | 71° 20′ |
| $p(001)$ | : | $a^1(\bar{1}01)$ | 39° 23′ |
| $e^1(011)$ | : | $g^1(010)$ | 63° 35′ |
| $m(110)$ | : | $g^1(010)$ | 53° 27′ |

The ratios of the parameters obtained from these values are:

$$a : b : c = 0{\cdot}793 : 1 : 0{\cdot}531$$

and the angle β is 110° 43′.

The crystals are optically positive. A thin plate (001) shows an optic axis pole at the limit of the field. The plane of the optic axes is parallel to $g^1(010)$ and the greatest refractive index $n_\gamma$ is in the direction nearly perpendicular to $p(001)$ in the obtuse angle of the $b$- and $c$-axes. No dichroism was observed.

Rotating crystal radiograms were taken with $a$, $b$, $c$ and [101] as rotating axes. The pictures generally show diffraction spots only in the proximity of the direct beam.

The spots corresponding to the $b$- and [101]-axes are sharp and the length of the axes deduced from these radiograms are:

$$b = 27{\cdot}30\ k\text{X}. \quad (101) = 21{\cdot}72\ k\text{X}.$$

The radiogram corresponding to the $c$-axis is not very well defined; apparently, however, there is a periodicity which together with that of the $b$-axis gives the value $c/b = 0{\cdot}524$, in agreement with the goniometric results.

From the very accurate value of the $b$-axis, and using the goniometric ratios, the length of the $a$-

and $c$-axes may be calculated with an accuracy which we think is better than that obtained by the absolute measure of the axes. So we have

$$a = 21{\cdot}64\ k\text{X.}; \quad c = 14{\cdot}50\ k\text{X.}$$

The volume of the unit cell, $V = abc \sin \beta$, is 8,012 $k$X.$^3$ $\pm$ 1 per cent.

The density, measured accurately with the Berman torsion balance, is 1·18 $\pm$ 1/2 per cent.

From the well-known formula

$$n = \frac{V.d}{M \times 1{\cdot}65},$$

we have $nM$ (molecular weight of the unit cell) = 5,730.

The number of molecules in the unit cell is unknown.

We determined the proline in actinomycin hydrolysate by microbiological assay[2] and calculated the molecular weight on this basis. 100 mgm. of actinomycin were hydrolysed by refluxing for 48 hr. with 6 $N$ hydrochloric acid at 110°. The residue was evaporated to dryness, a small quantity of water was added and the suspension was filtered. The volume of the filtrate was made up to 100 c.c. by washing the filter. For the microbiological assay, 15 c.c. of the resulting solution was diluted to 100 c.c., to give a solution containing 150 $\gamma$ of actinomycin per c.c.; 24·3 $\gamma$ per c.c. of proline was found. The probable accuracy of this result appears to be $\pm$ 5 per cent, judging from simultaneous assay of a known mixture of amino-acids.

From the molecular weight of proline (115), it is possible to calculate the molecular weight of actinomycin :

$$\frac{150 \times 115}{24{\cdot}3} = 710 \pm 35$$

(assuming one mole of proline per mole of actinomycin).

On the basis of the above calculations, the number of molecules per unit cell appears to be eight, and the molecular weight of actinomycin would be 716 $\pm$ 15.

The Rast cryoscopic method, however, gives a lower value (576)[1], and in this case the calculated molecular weight may be 573 (assuming that there are ten molecules per unit cell).

The value obtained from the microbiological assay appears to be better than the one obtained by cryoscopy, because of the very low solubility of the actinomycin in camphor.

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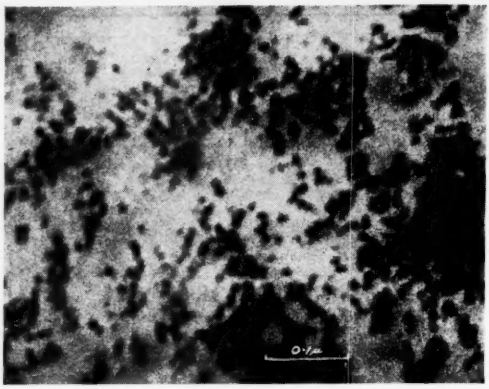
## An Electron Microscope Study of Nucleic Acid

Probably the only macromolecules which have been observed directly are some of the larger proteins seen with the electron microscope. Although many polymers have a molecular size as great as these proteins, the width of the polymer chains is too small for them to be visible. The following observations on nucleic acid, however, suggest that these molecules can be seen individually.



A preliminary study has been made in the electron microscope of calf thymus sodium nucleate prepared by Signer, Butler and Fraser. In general, micrographs were obtained of replicas of the surfaces of dried drops from aqueous solution or smeared sheets of thymonucleate, the replicas being prepared by shadowing the thymonucleate with palladium – gold at $\tan^{-1}$ 1/6 and coating with a 'Formvar' film. The replica was then floated off on the surface of water or a dilute solution of sodium hydroxide, when the thymonucleate dissolved. Other methods of preparation were also used ; but that described is superior in avoiding shadowing of structure due to the 'Formvar' itself. The specimens before replicating were all faintly birefringent.

All the specimens examined showed globules of varying diameter with an average value of about 100 A. This would be compatible with a polymer having a distribution of molecular weights about a mean value of approximately $10^6$. Close examination of the clear regions of the micrographs (see accompanying reproduction) suggests that they are genuinely free of globules ; that is, the thymonucleate molecules are in a form the details of which are below the resolving power of the electron microscope. A spurious effect, due possibly to diffraction or shadowing, was seen on a few micrographs which could be interpreted as showing the molecules as fibres of about 50 A. diameter, in support of Oster and Nixon's observations[1] ; but otherwise no evidence has yet been obtained of any fibrillar structure, although occasionally globules tend to align themselves to give the appearance of a fibre similar to those found by Scott[2] ; it is not certain, however, to what extent this effect is due to drying.

A tentative explanation of these results is that, on drying, surface molecules are unstable and coil up ; but in the bulk of the material the molecules remain extended owing to the intermolecular forces and lie parallel to one another, as shown by X-ray diffraction, birefringence, etc. (see, for example, ref. 3). The breadth of a polynucleotide chain is expected to be about 15–20 A., so that in the extended state the molecules are below the resolution of the microscope. Occasionally, therefore, the 'smooth' formation of the bulk material is seen in regions free from coiled molecules.

Further work is in progress, and a more detailed account will be published later.

I wish to thank Prof. R. Signer, Dr. J. A. V. Butler and Dr. M. J. Fraser for sodium thymonucleate; Prof. J. T. Randall for advice and encouragement throughout the work; and Dr. M. H. F. Wilkins for the preparation of some of the specimens and for valuable discussions.

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## Epitaxis of Rubidium Iodide on a Barium Stearate Substrate Deposited on Mica

The oriented overgrowth formed by rubidium iodide on a mica substrate has been recorded by Royer[1] and others. In the course of repeating these experiments the substrate was modified; instead of a muscovite substrate, barium stearate deposited on freshly cleaved muscovite was used, the deposit being built up as a succession of monomolecular layers.

Rubidium iodide crystallizing from an aqueous solution on a substrate of glass or of barium stearate (one to nine molecular layers) on glass does so in the cubic habit, whereas on mica the crystal outline is in most cases an equilateral triangle with sides parallel to the traces of the (010), (110) and ($1\bar{1}0$) planes of mica, the (111) plane of rubidium iodide being parallel to the (001) plane of mica. Some crystals, however, assume the cubic habit in random orientation with respect to the mica; but if dilute solutions are used their number is very much reduced. If the crystallization is carried out on barium stearate layers deposited on the mica, the proportion of unoriented cubic crystals increases with the thickness of the barium stearate barrier.

Layers of one, three, five, six, seven and nine monolayers were used, and with nine layers oriented crystals only occasionally appeared. It appeared, therefore, that a barium stearate barrier of nine molecules thick was sufficient to eliminate the influence of the mica.

In the (111) plane of rubidium iodide, the directions of greatest atom density are those which form the boundaries of the triangular crystals. The directions next to these in atom density would outline a hexagon; hexagonal crystals, which are absent when rubidium iodide crystallized directly on mica, appeared when a barrier of barium stearate of three, five or seven layers was interposed; also the triangular crystals frequently grew in connected groups of three, especially when deposition was on a monomolecular barrier.

The layers of barium stearate were deposited by dipping a freshly cleaved mica slip, *c.* 50 mm. × 7·5 mm., through a monomolecular layer of barium stearate spread on a water surface, the technique being that described by Blodgett[2].

I wish to acknowledge the assistance of Mr. D. C. Bisset of this Department, who undertook the deposition of the monolayers.

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[1] Royer, *C.R. Acad. Sci., Paris*, **179**, 1610 (1924).
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(1) Rubidium iodide crystals grown on mica. (2) Rubidium iodide crystals grown on a three-molecule layer of barium stearate deposited on mica, showing the development of hexagonal outlines (*a*), an unoriented cubic crystal (*b*), and a connected group of three (*c*). (3) Connected groups of three crystals growing on a monolayer of barium stearate on mica. In each photograph the longest side is parallel to the *b*-axis of the mica, and the magnification × 60

## Intense Gallium X-Rays for Microradiography and Diffraction Investigations

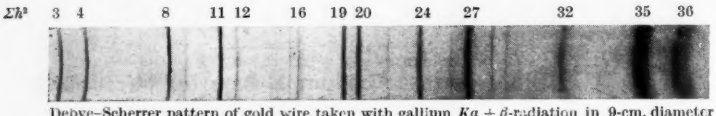
The identification of segregates in ferrous and non-ferrous alloys by the technique of microradiography[1–4] is now established as an extremely valuable complement to the conventional optical micrographic procedures. The contrast between segregate and matrix is independent of the etching characteristics of the metal, but depends, instead, on the relative absorption of the X-ray beam through a finite depth of specimen. Since the linear absorption coefficient $\mu$ is $C \cdot N^4 \rho \lambda^3$, where $N$ is the atomic number of the absorbing element, $\rho$ its density, $\lambda$ the wave-length of X-rays and $C$ a constant between absorption edges, it follows that, provided suitable wave-lengths are available, a segregated element may be positively identified by X-ray methods alone. When it is sought to distinguish between two elements close to each other in atomic number, it is possible to accentuate the contrast in X-ray absorption by choosing a radiation with a wave-length lying between the $K$-absorption edges of the elements.

For the bulk of alloys normally investigated, the range of wave-lengths available for microradiographic examination is, on the whole, quite adequate, with the exception of the commercially important group which comprises the brasses. As shown in the accompanying table, the only radiation capable of discriminating satisfactorily between copper and zinc-rich segregates is the $K\alpha$-radiation of gallium, and this radiation has hitherto not been available.

On account of its extremely low melting point (29·75° C.), it would be impossible to employ gallium as a target material in the normal types of sealed-off or demountable X-ray tubes, unless the current were kept down to a few micro-amperes. This in its turn, would make exposure periods inordinately long and quite impracticable except for very special purposes. However, the situation is quite different when a rotating anode X-ray tube is employed. By carefully

| Target material and wave-length in A. | | Linear absorption coefficient $\mu$ Cu | Zn |
|---|---|---|---|
| 0·559 | Ag | 236 | 201 |
| 0·585 | Pd | 265 | 233 |
| 0·613 | Rh | 303 | 269 |
| 0·708 | Mo | 443 | 391 |
| 1·339 | Ga | 3440 | 426 |
| 1·433 | Zn | 425 | 350 |
| 1·538 | Cu | 470 | 421 |
| 1·656 | Ni | 580 | 514 |
| 1·786 | Co | 720 | 620 |
| 1·933 | Fe | 882 | 780 |
| 2·100 | Mn | 1080 | 970 |
| 2·287 | Cr | 1370 | 1205 |

cleaning the cylindrical copper surface of the 4-in. diameter anode of a 'Gyrotron' X-ray tube[5], it was quite a simple matter to cover its slightly warmed surface with a uniform thin layer of gallium, simply by rubbing it on until it adhered. A continuous output of X-rays corresponding to a mean current of 80 m.amp. at 40 kVp. with focal spot dimensions 0·8 mm. × 8·0 mm. could easily be achieved. During the emission of X-rays, the gallium at the focal spot is, of course, liquid, but instantly freezes on moving away from the electron stream. So adherent is the film and so short is the period in which it is liquid, that no gallium is thrown off the anode surface due to centrifugal forces, nor, because of the efficient cooling, is there any intergranular attack which would cause disintegration of the copper base.




Debye–Scherrer pattern of gold wire taken with gallium $K\alpha + \beta$-radiation in 9-cm. diameter camera. Exposure 60 m.amp., 40 kVp., 1½ min.

Since the focal spot is small, the intense beam of gallium radiation may also be employed for X-ray diffraction work. A typical Debye–Scherrer diffraction pattern of gold wire in the 'as drawn' condition and taken in a 9-cm. diameter camera with gallium $K\alpha + \beta$-radiation is reproduced herewith. The exposure period, with the tube operating at only 60 m.amp. and 40 kVp., was approximately 1½ min.

The wave-length of gallium $K\alpha$-radiation is appreciably shorter than that of copper $K\alpha$. Thus, in suitable cases, much more information may be obtained from gallium radiation diffraction patterns than copper, since additional reflexions at higher values of $\sin\theta/\lambda$ are possible.

The availability of this new radiation emphasizes the advantages of a rotating anode X-ray tube over the conventional demountable tube fitted with a stationary target. Not only does it make more power available with normal radiations, thereby curtailing exposure times, but also its flexibility enables entirely new techniques to become available.

I should like to express my thanks to the Mond Nickel Co., Ltd., for permission to publish this communication.

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## Applications of Multiple-Beam Interferometry

Prof. S. Tolansky[1] has made some comments on communications by Bruce[2] and Bruce, Macinante and Kelly[3] on the production and applications of transmission-like reflexion fringes. I am grateful for the reference to the paper by Lummer[4] in which the principle of eliminating beams in a Haidinger fringe system is mentioned.

The first of our communications refers to a Fizeau fringe system, where the relevant beams were eliminated practically, in a very simple manner. The transmission-like reflexion fringes so produced were used with particular success in vibration measurement. No claim is made for the extensive use of such fringes in the topographical study of small areas where high magnification is required. They have been produced in the low-magnification systems so frequently used in the interferometry of length.

It is not suggested that the reflexion fringes shown in the communication are the optimum in contrast, and it is agreed that reflexion fringes may be used in vibration studies; but we have found the transmission-like reflexion fringes a distinct advantage in our work.

The second communication, on vibration measurement, had been submitted for publication before we had seen the papers by Tolansky[5] and Tolansky and Bardsley[6].

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## Sonic Layers in the Sea

The article on 'scattering' layers in the sea by A. C. Burd and A. J. Lee in *Nature* of April 21[1] was read by us with much interest since such layers have been frequently observed in Scottish waters during the past three years.

The increasing use of the echometer as a fish-locating device during the past few years has raised the important problem of the assignment of characteristic echo traces to specific sound-reflecting surfaces. Hodgson[2] has shown that it may be possible at certain seasons and at particular times of the day to distinguish between shoals of several species of fish by the shape, density and texture of the echo traces; but traces are often obtained which cannot so readily be ascribed to particular organisms. Among these is the type, illustrated by Burd and Lee, which appears as a diffuse layer with the lower boundary frequently ill-defined; it is often recorded for long distances as an uninterrupted trace at varying depths from the sea-bed. For example, in our records such traces have extended for distances up to 35 miles on the

Fig. 1. Specimen of diffuse scattering layer obtained on M/S 12 Kelvin Hughes 14 kc./s. echo-sounder aboard the Scottish Home Department's F.R.S. *Clupea* while operating on Peterhead fishing grounds, August 5, 1948. (Depth marks on echo-trace are at 0, 20, 40 fathoms, etc., and the time interval between marks is 3 min.)

Moray Firth herring grounds. Some of our traces show the vertical migration observed by Burd and Lee, whereas others have been observed in the upper water layers in full daylight. This suggests that the 'scattering' layers may be produced by a variety of pelagic forms which sometimes are associated in the same layer. An interesting example in support of this is shown by the trace in Fig. 1 (supplied by Dr. H. Wood). This was detected near the sea-bed at sunset on August 5, 1948, on the Peterhead fishing grounds. On the approach of darkness the trace split into two parts, one of which rose towards the surface and stopped in the neighbourhood of a sharp thermocline, while the other persisted at a level about 10 fathoms from the sea-bed.

In order to ascertain the nature of this type of trace, we attempted to photograph the organisms with an underwater ciné-camera and a 1,000-watt light source, and to observe their reaction to underwater light stimuli. During 1950 some identifiable photographs (including fish and jellyfish) were obtained. One experiment in particular revealed something of the reactions and the type of the organisms producing traces of this nature. On July 20, 1950, off Fraserburgh, an extensive sonic layer was picked up in darkness at 0100 hr. This trace appeared as a diffuse record at approximately six fathoms from the surface. The vessel was stopped, and the sequence of events was as follows (the results being illustrated in Fig. 2). (1) The lamp was lowered a few feet below the surface of the water, and was switched on and left in this position for 15 min.; the scattering layer descended to a depth of approximately 10 fathoms and gradually increased in density. (2) The lamp was switched off for 3 min.; the layer remained dense and rose rapidly towards its previous level. (3) The lamp was lowered into the middle of the layer and was switched on; the greater part of the trace descended immediately to 20 fathoms; but some organisms remained at the level of the light. (4) The light was hauled to the surface and held there for 10 min. The main part of the scattering layer rose quickly to 10 fathoms; but some organisms rose to the surface. (5) The light was then switched off and the main body of the trace rose to its original level of approximately 6 fathoms.

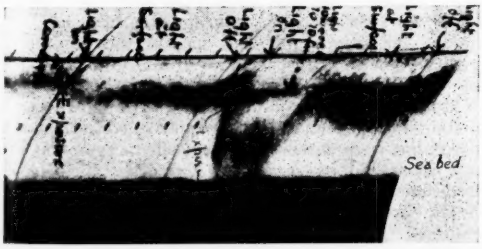


Fig. 2. Echo-trace illustrating experiments referred to in text. Time sequence of events indicated by numbered arrows. (Each tick denotes the passage of 3 min.)

The conclusions which we draw from these observations are: (*a*) Most of the organisms giving rise to this scattering layer were very active swimmers; their descent from 10 to 20 fathoms in a few seconds presumably eliminates from sole consideration such drifting forms as medusæ and the smaller plankton organisms. (*b*) The main body of the trace resulted from organisms showing positive phototaxis to a light intensity corresponding to that at a depth of 10 fathoms below the 1,000-watt lamp. (*c*) A smaller portion of the trace was composed of organisms showing a greater positive phototaxis, being attracted to within a few feet of the lamp; these we were able to identify from samples taken with a small hand-scoop as young scaled three-bearded rockling (*Onos tricirratus*) of 4–8 cm. in length, and sand eels (*Ammodytes epp.*) of 10–15 cm. in length, in the ratio of approximately 20 : 1.

In the absence of identifiable photographs on this occasion, it is not possible to determine to what extent these two species contributed to the main body of the patch which concentrated at approximately 10 fathoms below the light source, and in view of the difference in reaction to the light stimuli it is probable that species other than these fish were also present. Presumably a similar specific difference holds for Fig. 1.

These observations seem to have general interest in relation to the conflicting beliefs held as to the nature of the *deep* 'scattering' layers—whether they are of physical or biological origin. Testing their reactions to lights in their neighbourhood might help to resolve this question with high probability.

The presence of fish as one component of this type of scattering layer provides a possible explanation of our failure to secure more identifiable photographs with the camera-light unit used in these experiments. This particular unit had independent switches for the light and camera, the camera being set in operation before the light. Fig. 2 demonstrates clearly the immediate flight response of part of the scattering layer to light stimuli, which would have taken the organisms responsible rapidly out of the field of focus of the camera. Some species of fish are also known to adopt similar flight reactions to sound stimuli, and it is possible, therefore, that the noise made by the ciné-camera mechanism would have caused a similar flight response. During the present season a single-frame camera with electronic flash is being used. In this way it is hoped that all component organisms will be photographed before any movement away from the field of focus of the camera can be effected.

Further records of the presence of diffuse scattering layers in Scottish waters have come to our notice from a number of herring fishermen. One such record, kindly provided by Skipper G. Leslie of the drifter *Betty Leslie*, and from the Shetland herring grounds in June 1950, is of interest in providing further evidence of the presence of young fish in the scattering layer. In this instance a widespread diffuse trace, similar to those illustrated above, was obtained from the upper water layers, and Skipper Leslie

shot his drift-nets at the trace depth. Although the trace persisted during the whole of the time that the nets were in the water, the total catch was only one adult herring; but entangled in the nets were vast numbers of small fish, a sample of which was collected and identified as post-larval unscaled herring of 3–4 cm. in length.

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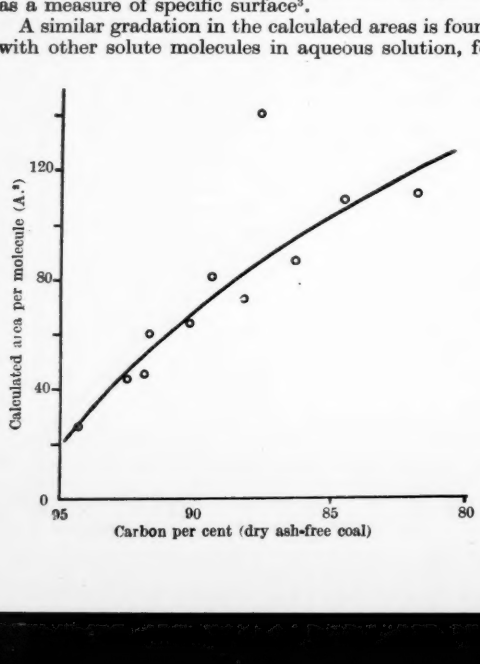
## Adsorption on Coal

In a recent letter in *Nature*[1], Lecky *et al.* have reported that surface areas of coal obtained from low-temperature nitrogen adsorption are considerably smaller than areas determined from water and methanol adsorption, while Malherbe[2] found a similar discrepancy between areas of coal determined from low-temperature argon adsorption and heats of wetting in methanol. The doubts thus cast on the extent of the internal surface area of dry coal samples do not, however, necessarily apply to coal in its wet and swollen state, and it is in this form that coal is encountered in wet processing and also, as dust, in the lungs of coal-miners.

I have studied adsorption of organic molecules from aqueous and alcoholic solutions on coal. Adsorption on high-rank coals (for example, the anthracites) is often very high, even with low molecular weight solutes which give no evidence of multimolecular adsorption, suggesting that for these coals the heat of wetting in methanol does not over-estimate the internal surface. The area per molecule of solute, calculated from the apparent adsorption at final concentrations of 0·100 N, decreases as the rank of coal (and percentage carbon) decreases and the oxygen content increases. The accompanying graph gives results for the area per solute molecule in the case of acetic acid, heats of wetting in methanol being used as a measure of specific surface[3].

A similar gradation in the calculated areas is found with other solute molecules in aqueous solution, for example, formic acid, methyl and ethyl alcohol, methyl and ethyl acetate. The slope of the curves is dependent on the particular solute, being least pronounced for methyl alcohol. Adsorption presumably takes place through the non-polar portion of the solute molecule; Traube's law for homologous series is valid for coal except in cases where molecular sieve action is pronounced.




The gradation in calculated area per molecule is probably largely due to a true decrease in adsorption per unit area as the coal becomes more hydrophilic. Dependence of heats of wetting on the composition of the surface may be a contributory factor.

The available results will be more fully reported elsewhere. The observations reported above were obtained on coal samples supplied by the British Coal Utilization Research Association, by whom the heat of wetting determinations were carried out.

G. Garrod Thomas

Pneumoconiosis Research Unit,
Medical Research Council,
Llandough Hospital,
Nr. Cardiff.
July 26.

[1] Lecky, Keith Hall and Anderson, *Nature*, **168**, 124 (1951).
[2] Malherbe, *Fuel*, **30**, 97 (1951).
[3] Maggs, Proc. Conference on Ultra-fine Structure of Coals and Cokes, 95 (B.C.U.R.A., 1944).

## Observation of Cool Flames with Ethylene

In the course of investigations into the inflammability of ethylene/oxygen/nitrogen mixtures, some interesting observations have been made on the type of flame produced by spontaneous ignition at 300°. Experiments were carried out in a cylindrical steel bomb (explosion cavity 3·8 cm. dia. and 15·3 cm. long) mounted vertically and fitted with a quartz window near the top.

Several mixtures, containing 5–6 per cent of oxygen and 15–68 per cent of ethylene, were fed into the bomb at 300° and pressures up to 40 atm., and found to give rise spontaneously to two quite different types of flame.

(1) At 17–41 atm., a pale blue flame moving downward through the mixture. The flame front was about $\frac{1}{8}$ in. thick, nearly planar, and possessed no tail. It travelled at a speed of approximately 1 cm./sec. and was associated with a gentle pressure 'pulse' of 0·5–1·0 atm. Titanic sulphate indicated small quantities of peroxides in samples of the gas taken immediately before or immediately after the passing of the flame. 50–90 per cent of the oxygen was consumed, 20–28 per cent being converted to formaldehyde and 1–2 per cent to acetaldehyde.

(2) At 25–41 atm., normal ignition occurred. The flame was bright red and moved too rapidly for visual perception of the flame front, that is, at least at (and possibly much faster than) 50 cm./sec.

Much soot was produced and the gauge registered a sudden kick that sometimes exceeded 30 atm. No peroxides were detected, but all the oxygen was used up, about 16 per cent being converted to formaldehyde and 1–2 per cent to acetaldehyde.

The pressure at which the flame characteristics changed depended on the composition of the gas, and for each gas was located within a range of some 2–3 atm. Within this range, a two-stage ignition could sometimes be observed, the blue flame being

followed by a normal ignition in the space of about one second.

The low-pressure flame has the following characteristics of a 'cool' flame: (i) pale blue and non-luminous; (ii) slow speed; (iii) small pressure pulse; (iv) capacity to lead to a two-stage ignition; (v) associated with peroxide and aldehyde formation.

Up to the present, however, attempts to produce similar flames artificially in cold gas mixtures with a feebly glowing platinum spiral have not met with any success.

Townend, in a study of the auto-ignition of ethylene/air mixtures[1], found no evidence of cool flames despite exploration over a wide range of values of temperature, pressure and composition. Since the present study differs only from this work in composition, namely, a greater quantity of nitrogen for all ethylene concentrations, it seems likely that the diluent effect of the nitrogen is a vital factor in the formation of cool flames in ethylene.

These observations were made in the Fuel Department of the University of Leeds, and we wish to express our appreciation of the interest taken by Prof. A. L. Roberts in this work. A detailed account will be published in due course. We wish to thank the directors of the British Oxygen Company, Ltd., for permission to publish this letter.

J. R. Abbott
S. A. Miller

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Morden,
London, S.W.19.

[1] Kane and Townend, *Proc. Roy. Soc.*, A, **160**, 174 (1937).

## Mode of Decomposition of Sulphur Sesquioxide

Wöhler and Wegwitz[1] tentatively assumed the formation of sulphur monoxide as an unstable intermediate compound in the decomposition of sulphur sesquioxide and thus accounted for the formation of thiosulphate and polythionates. Neither Partington and Vogel[2] nor Wöhler and Wegwitz obtained sulphur monoxide during the decomposition.

While studying the properties of sulphur sesquioxide, I heated a sample of the sesquioxide in an all-glass apparatus at 60° C. The volatile products of decomposition, when cooled in a U-tube immersed in liquid air, condensed to a pale yellow solid. On shaking with cold dilute alkali, this yellow residue gave rise to sulphide, sulphite, thiosulphate and sulphur.

When sulphur monoxide prepared by the combustion of sulphur in oxygen at low pressure (Schenk[3]) is cooled at the temperature of liquid air, a similar yellow condensate is obtained. On hydrolysis with cold dilute alkali the condensate gives rise to sulphide, sulphite, thiosulphate and sulphur, as in the case of the products of decomposition of sulphur sesquioxide mentioned above. It is thus concluded that the condensates in the two cases are the same. In other words, this experiment shows that the sulphur monoxide is produced during the decomposition of sulphur sesquioxide. It may be mentioned that the formation of the products of alkali hydrolysis has been explained by B. S. Rao[4] on the basis that disulphur monoxide is produced during the decomposition of sulphur monoxide.

Further support for this observation comes from the following experiment. When sulphur trioxide is led into a solution of sulphur in dry carbon tetrachloride, a dark blue solution of the sesquioxide is obtained. On subjecting this to alkali hydrolysis, it is noticed that sulphide, sulphite, thiosulphate and sulphur are produced. No detectable amounts of polythionates are formed. The production of sulphide during the hydrolysis of sulphur sesquioxide has been observed for the first time, and this is attributed to the production of sulphur monoxide as the primary product during the hydrolysis. The results of a representative experiment are:

| Amount of sulphur (mgm.) in carbon tetrachloride (80 gm.) | Sulphur (mgm.) as $SO_3$ added to carbon tetrachloride | Products of alkali hydrolysis (in mgm.) | | | |
|---|---|---|---|---|---|
| | | Sulphur as sulphide | Sulphur as sulphite | Sulphur as thiosulphate | Free sulphur |
| 97·92 | 97·92 | 18·2 | 99·2 | 36·8 | 40·9 |

It is presumed that sulphur sesquioxide can decompose in two ways:

(i) $S_2O_3 \longrightarrow S + SO_3$
(ii) $S_2O_3 \longrightarrow SO_2 + SO$.

The amount of sulphur monoxide produced can be calculated quantitatively from the products of alkali hydrolysis by the method developed by B. S. Rao[4]. It has been found in this case that 82 per cent of the decomposition of sesquioxide goes according to reaction (ii). This value is in good agreement with the percentage (80 per cent) obtained by the German authors. It can therefore be concluded that sulphur monoxide is one of the primary products of decomposition of sulphur sesquioxide.

Further details of the work will be published elsewhere.

I wish to express my thanks to Dr. B. Sanjiva Rao and Dr. M. R. Aswathanarayana Rao for their interest in this work.

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Bangalore 3.

[1] Wöhler and Wegwitz, *Z. anorg. Chem.*, **213**, 129 (1933).
[2] Partington and Vogel, *J. Chem. Soc.*, **127**, 1514 (1925). Partington. *Nature*, **164**, 467 (1949).
[3] Schenk, P. W., *Z. anorg. allg. Chem.*, **220**, 260 (1935).
[4] Sanjiva Rao, B., *Proc. Ind. Acad. Sci.*, **10**, 491 (1939).

## Paper Chromatography of Nicotinic Acid Derivatives

Leifer *et al.*[1] have reported the paper chromatography of nicotinic acid with the use of microbiological assay. While our work was in progress, Huebner[2] described a spot test for detection of some pyridine derivatives. The present work describes sensitive qualitative techniques developed in this Laboratory for the detection of tertiary and quaternary pyridinium compounds. The laborious procedure involved in the microbiological method of Leifer *et al.*[1] is obviated by rapid colour or fluorescent tests. For the colour test, advantage was taken of König's[3] reaction, namely, the formation of coloured compounds when tertiary pyridine derivatives are treated with cyanogen bromide and a primary aromatic amine. The fluorescence test allows the detection of quaternary nicotinamide derivatives. Use is made of the formation of bluish-white fluorescent substances when quaternary pyridine compounds with

a side chain CO—NH—*R* in the β position are treated with methyl ethyl ketone and ammonia[4].

From a number of solvent systems, those were chosen which allowed the best separations of the various compounds (Tables 1 and 2). After descending chromatograms had been run on Whatman paper No. 1 overnight, the papers were dried at room temperature and treated in the following way.

(1) *Tertiary pyridine compounds.* The dry paper was placed in a closed glass tank for 1 hr. at room temperature over a cyanogen bromide solution, prepared according to Wang and Kodicek[5]. It was then sprayed with 2 per cent *p*-aminobenzoic acid (2 gm. of *p*-aminobenzoic acid dissolved in 75 ml. 0·75 *N* hydrochloric acid and made up to 100 ml. with 96 per cent ethanol). The positions of the different compounds are revealed by their colours (see diagram). It is possible to detect quantities as small as 0·1 microgram.

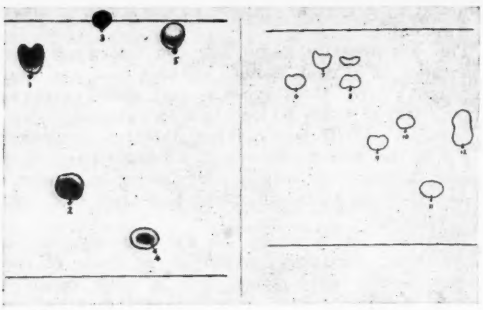
(2) *Quaternary pyridinium compounds.* The dry paper was placed over a mixture of methyl ethyl ketone and ammonia (1 : 1) for 1 hr. in a closed glass tank at room temperature. The relative positions could be detected by their bluish-white fluorescence under ultra-violet (see diagram). Quantities as small as 0·05 μgm. (nicotinic acid equivalents) could be detected.

Table 1. $R_F$ Values of some Tertiary Pyridine Compounds (Descending Chromatograms)

| Material | Solvent System | | | | | Colour |
|---|---|---|---|---|---|---|
| | *n*-Butanol, water | *n*-Butanol, water + 0·1 per cent ammonia (bottom) | *iso*-Butanol, water | 80 per cent acetone | Methyl ethyl ketone : acetic acid : water, 49 : 1 : 50 : | |
| Nicotinic acid | 0·21 | 0·19 | 0·17 | 0·55 | 0·68 | yellow |
| Nicotinamide | 0·69 | 0·69 | 0·69 | 0·78 | 0·59 | deep yellow |
| Nicotinuric acid | 0·11 | 0·06 | 0·08 | 0·44 | 0·45 | orange |
| Diethyl nicotinamide (coramine) | 0·90 | 0·89 | 0·91 | 0·89 | 0·90 | pink |

The $R_F$ values of some nicotinic acid derivatives determined by these techniques are listed in Tables 1 and 2. The $R_F$ values of the leading front were taken.

The results show that the $R_F$ values of nicotinamide and coramine were more or less consistent irrespective of the solvent used, whereas those of the more acidic compounds (nicotinic acid, nicotinuric acid) moved slower in neutral or alkaline than in acidic solvents.



(*a*) *n*-butanol – water (*b*) 60 per cent *n*-propanol

Descending chromatograms in (*a*) *n*-butanol, water and (*b*) 60 per cent *n*-propanol.
(*a*) Coloured spots from tertiary nicotinyl compounds treated with cyanogen bromide and *p*-aminobenzoic acid : (1) nicotinic acid ; (2) nicotinamide ; (3) bound nicotinic acid preparation ; (4) diethylnicotinamide (coramine) ; (5) nicotinuric acid. (*b*) Fluorescent spots from quaternary nicotinamide compounds treated with methyl ethyl ketone and ammonia : (6) diphosphopyridine nucleotide ; (7) triphosphopyridine nucleotide ; (8) mixture of (6) and (7) ; (9) N′-methylnicotinamide ; (10) N′-methylnicotinuric acid betaine ; (11) 3-carbamyl-tetra-acetyl-N′-D-glucosidyl pyridinium bromide ; (12) 3-carbamyl-N′-2′-hydroxyethyl pyridinium bromide

Thus, for example, the $R_F$ value for nicotinic acid was 0·70 when *n*-butanol–water–1 per cent acetic acid was used, compared to 0·21 in *n*-butanol–water.

The bound nicotinic acid (a purified preparation from wheat bran[6]) did not move with any of the solvents investigated, indicating, in agreement with the findings of Chaudhuri and Kodicek[6], that the nicotinic acid is bound to a moiety which makes it insoluble in the organic solvents tested (see diagram).

The butanol, 80 per cent acetone and methyl ethyl ketone solvent systems were most suitable for the tertiary nicotinyl series. For the quaternary nicotinamide derivatives, with the exception of the diphospho- and triphospho-pyridine nucleotides, 60 or 80 per cent propanol proved to be the most suitable solvents. For diphosphopyridine nucleotide and triphosphopyridine nucleotide, 60 per cent acetone, 60 per cent *n*-propanol or 60 per cent ammonium sulphate in *M*/10 phosphate buffer (*p*H 6·8) with 2 per cent *n*-propanol were the best solvents.

When diphosphopyridine nucleotide was developed in the 60 per cent ammonium sulphate system, two spots were observed with $R_F$ values of 0·38 and 0·86, respectively. The second spot, which is only faintly fluorescent, is most probably due to a split product formed by the action of the solvent system. Its $R_F$ value is identical with that of the quaternary nicotinyl riboside, kindly supplied by Dr. L. J. Haynes.

Table 2. $R_F$ Values of Some Quaternary Pyridinium Compounds (Descending Chromatograms)

| Material | Solvent system | | | | Method of detection |
|---|---|---|---|---|---|
| | 60 per cent acetone | 80 per cent acetone | 60 per cent *n*-propanol | 60 per cent ammon. sulphate in phosphate buffer (*p*H 6·8) with 2 per cent *n*-propanol | |
| N′-methylnicotinamide | 0·71 | 0·47 | 0·54 | 0·83 | Bluish-white fluorescence |
| N′-methylnicotinuric acid betaine | 0·57 | 0·26 | 0·43 | — | ,, |
| Carbamyl-N′-2′-hydroxyethyl pyridinium bromide* | 0·74 | 0·36 | 0·57 | — | ,, |
| Diphosphopyridine nucleotide | 0·43 | 0·10 | 0·26 | 0·38 | ,, |
| Triphosphopyridine nucleotide | 0·30 | 0 | 0·15 | 0·54 | ,, |
| 3-Carbamyl-tetra-acetyl-N′-D-glucosidyl pyridinium bromide* | 0·94 | 0·84 | 0·81 | — | ,, |
| 3-Carbamyl-N′-ribosidyl pyridinium bromide* | 0·62 | 0·33 | 0·48 | 0·86 | ,, |

* Prepared by Haynes and Todd (ref. 7).

N'-Methylnicotinuric acid betaine could not be traced in the ammonium sulphate solvent system. This may be due to the removal of glycine with ammonium sulphate from the β side-chain, thus leaving a carboxylic group which would not give a fluorescent condensation compound with methyl ethyl ketone and ammonia[4].

Further work is in progress to apply these procedures to biological materials.

We wish to thank Dr. L. J. Haynes for supplying us with some of the quaternary nicotinyl compounds and Dr. E. C. Slater for the gift of diphosphopyridine nucleotide and triphosphopyridine nucleotide.

E. Kodicek
K. K. Reddi

Dunn Nutritional Laboratory,
University of Cambridge
and Medical Research Council. May 8.

[1] Leifer, E., Langham, W. H., Nyc, J. F., and Mitchell, H. K., *J. Biol. Chem.*, **184**, 589 (1950).
[2] Huebner, F. H., *Nature*, **167**, 119 (1951).
[3] König, W., *J. prakt. Chem.*, **69**, 105 (1904).
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[5] Wang, Y. L., and Kodicek, E., *Biochem. J.*, **37**, 530 (1943).
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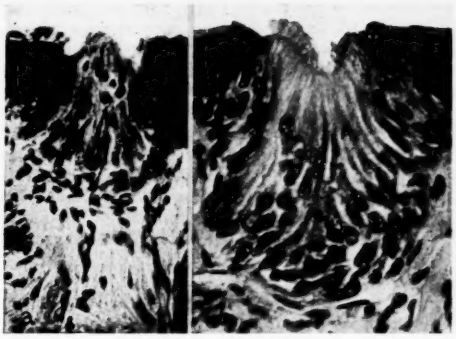
[7] Haynes, L. J., and Todd, A. R., *J. Chem. Soc.*, **303** (1950).

## New Lateral Line Sensory Organs in *Xenopus lævis* Daudin

During an investigation of a trematode infestation in *Xenopus lævis* a median ventral row of 'lateral' sensory organs was observed, which has not previously been described[1]. The observation was due to the nature of the infestation, and Fig. 1 is a photograph of a parasitized adult female toad. The parasites (*Strigeid metacercariæ*) encyst in all layers of the dermis beneath the lateral sense organs, and the position of these is emphasized by numerous large melanophores close to the cysts, while the rest of the skin remains paler than usual.

The median ventral row runs forward from the junction of the two ventral rows just anterior to the anus, and consists of three to six 'plaques'. It is an anterior continuation of the row that joins the anus to the lateral ventral rows, which Paterson[2] suggests are derived from the paired rows on the ventral fin of the tadpole. The median ventral row can sometimes be seen in normal animals, but is very inconspicuous. Its presence in these has been confirmed histologically (Fig. 2).

Fig. 1. *Xenopus lævis* D. Adult female with metacercarial infestation of the lateral line system. The melanosis provoked by the parasites discloses the presence of a hitherto unsuspected median ventral line



*a* *b*

Fig. 2. (*a*) Sensory epidermal bud from the median ventral 'lateral' line of *Xenopus lævis* D. Some nerve fibres, supplying the organ, are visible. × 180. Holmes silver impregnation. (*b*) Sensory epidermal bud from the upper lateral line of *Xenopus lævis*. × 270. Masson's trichrome. Note the presence of the central depression on the surface which is absent in (*a*)

The median ventral row differs from the other rows in that the plaques are short (less than 2 mm.) and are not raised above the surrounding skin; tactile organs, which usually alternate with the lateral line neuromasts along the plaque, are often absent, and the latter are smaller than usual, scarcely extending down into the dermis. The innervation appears normal.

Fuller accounts of these observations, of the infestation and of an investigation into the electrophysiology of the lateral sensory organs of *Xenopus* by one of us (R. W. M.), will be published elsewhere.

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R. W. Murray

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[1] Escher, K., *Acta Zool.*, **6**, 307 (1925).
[2] Paterson, N. F., *Quart. J. Micro. Sci.*, **81**, 161 (1939).

## The So-called Chromosome-Races of *Cardamine pratensis* and *Nasturtium officinale*

In his recent article on "Plant Chromosome-Races and their Ecology in Great Britain"[1], Dr. G. Haskell devotes a paragraph each to lady's smock (*Cardamine pratensis*) and to watercress (*Nasturtium officinale* agg.). So far as *Cardamine pratensis* is concerned, he omits to mention the work of Hussein[2,3], who has made by far the largest study of the distribution of the two chromosome-races of this plant in Great Britain. Haskell states that in Great Britain, as in Sweden, the form with the lower chromosome number ($2n = 30$) is characteristic of drier conditions than the form with the higher chromosome number ($2n = 56$). This was found by Hussein, who says: "The ecological difference found by Lövkvist holds good in most of the cases recorded; for example, Prof. R. D'O. Good, who kindly provided material

from Dorset, noted particularly that the large plant, now found to have the low chromosome number, occurred in quantity on the damp roadside banks characteristic of Marshwood Vale, whereas the smaller darker-leaved one ($2n = 56$) grew in wet meadows". It should also be noted that the chromosome number of *Cardamine pratensis* from Merton was found by Lawrence[4] to be $2n = 30$ (thus agreeing with counts made by Lövkvist[5] and Hussein[2,3] and with unpublished counts by myself for the lower chromosome number form) and not $2n = 32$ as stated by Haskell, although Lawrence did suggest that it may have arisen from $2n = 32$ by chromosome fusion.

Watercress should surely not have been included as an example of chromosome-races since, although Manton[6] suggested that the forms with $2n = 32$, 48 and 64 were diploid, triploid and tetraploid races of the same species, later work by Howard and Manton[7,8] showed conclusively that there are two quite distinct species of watercress, *Nasturtium officinale sensu stricto* with a chromosome number of $2n = 32$ and *N. microphyllum* (or *N. uniseriatum* as Howard and Manton called it) with $2n = 64$. The form with $2n = 48$ is the interspecific hybrid *N. microphyllum* × *officinale*. Moreover, it was shown quite conclusively that *N. microphyllum* was an allotetraploid and therefore that any differences between it and *N. officinale* were most likely to be due not to polyploidy but to the influence of other, unfortunately still unknown, parent species of *N. microphyllum*. Further, as Airy Shaw[9] has pointed out, the tetraploid species of watercress, namely, *N. microphyllum*, had been distinguished for many years by several European botanists as a distinct species.

It should also be noted that diploid watercress, namely *N. officinale sensu stricto*, is a perennial and not an annual as Haskell states and that Haskell's description of *N. microphyllum* as perennial winter watercress is misleading in another respect. The brown or so-called winter cress of the commercial grower is the hybrid *N. microphyllum* × *officinale* and not *N. microphyllum*, which is not cultivated[10]. Also, green or so called summer cress, *N. officinale*, is cultivated for winter use at the present time on a very large scale and the terms 'winter' and 'summer' cress are therefore to a large extent misnomers. It may be, as Haskell suggests, that *N. officinale* occurs in areas with a higher mean rainfall and *N. microphyllum* in areas with a lower mean rainfall; but when we mapped our records[11] for the distribution of the two species, it was not apparent to either Mr. A. G. Lyon or me. The suggested distribution is, moreover, an exception to the general rule proposed by Haskell in his last paragraph that tetraploids, not diploids, occur in the wetter places; but, if correct, it is easily understandable when we remember, as has been pointed out earlier, that *N. microphyllum* is an allotetraploid and not an autotetraploid. There is, however, further evidence about the distribution of the two watercress species which Haskell has omitted. Both Airy Shaw[12] and Howard and Lyon[11] give reasons for suggesting that *N. microphyllum* can tolerate lower *p*H values and calcium concentrations than *N. officinale*. It is hoped that further observations on this point will be published soon in *Biological Flora* accounts for the two species. Lastly, in discussing the distribution of watercress, it must always be remembered that, in addition to being a wild plant, watercress is cultivated in the south of England and that for many centuries prior to its cultivation it was eaten as a salad plant by man.

H. W. Howard

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[1] Haskell, G., *Nature*, **167**, 628 (1951).
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[3] Hussein, F., Rep. Bot. Soc. Brit. Isl. Conference of 1948, p. 77.
[4] Lawrence, W. J. C., *Genetica*, **13**, 183 (1931).
[5] Lövkvist, B., *Hereditas*, **33**, 421 (1947).
[6] Manton, I., *Z. Indukt. Abstamm. Vererb.*, **69**, 132 (1935).
[7] Howard, H. W., and Manton, I., *Nature*, **146**, 303 (1940).
[8] Howard, H. W., and Manton, I., *Ann. Bot.*, N.S., **10**, 1 (1946).
[9] Airy Shaw, H. K., *Kew Bull.*, No. 1, 39 (1947).
[10] Howard, H. W., *J. Min. Agric.*, **53**, 453 (1947).
[11] Howard, H. W., and Lyon, A. G., *Watsonia*, **1**, 228 (1950).
[12] Airy Shaw, H. K., Rep. Bot. Soc. Brit. Isl. Conference of 1948, p. 75.

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I am indebted to Dr. H. W. Howard for criticisms and comments on my survey of the ecology of British chromosome-races[1]. The following points may also be added.

(1) I am pleased to learn of Miss Hussein's studies on the distribution of *Cardamine pratensis* in Britain. However, in her map[2] she did not relate the widespread distribution of the higher chromosome-race and the restricted southerly distribution of the lower race to colonization following retreat of the ice.

(2) Lawrence[3] gave $2n = 30$ for the Merton *C. pratensis* and interpreted this as reduction from 32 through chromosome fusion. I put $2n = 32$ to avoid confusion with genuine aneuploidy due to actual loss of chromosomes.

(3) Dr. Howard's criticism of my using the term 'chromosome-race' with regard to *Nasturtium* species and their hybrid is of much wider significance. Darlington[4] has pertinently asked recently whether the chromosomes fit the species, and the problem of polyploid races within and between species has now been discussed at length by Löve[5]. He believes that all chromosome-races should be recognized as distinct species (even if morphological differences are slight), except asexually reproducing higher, uneven hybrids. Löve maintains that all chromosome-races show morphological differences when carefully examined and uses the term 'polyplotype' to refer to a polyploid regardless of whether it is an auto- or allopolyploid. This is useful, as Stebbins[6] has already indicated that many so-called auto-polyploids could be interpreted as allo-polyploids.

(4) Manton[7] referred to the summer watercress crop as being diploid and the winter crop as triploid. She said there was a marked tendency for diploids to behave as annuals unless conditions were especially favourable in the autumn, and ease of perennation was in part at least responsible for the use of the higher polyploid in winter. Dr. Howard's more recent observations will therefore clarify this point.

G. Haskell

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Bayfordbury,
Hertford.

[1] Haskell, G., *Nature*, **167**, 628 (1951).
[2] Hussein, F., Rep. Bot. Soc. Brit. Isl. Conf. of 1948, p. 77.
[3] Lawrence, W. J. C., *Genetica*, **13**, 183 (1931).
[4] Darlington, C. D., *Nature*, **167**, 662 (1951).
[5] Löve, A., *Caryologia*, **3**, 263 (1951).
[6] Stebbins, G. L., "Adv. in Genet.", **1**, 403 (1947).
[7] Manton, I., *Z. Indukt. Abstamm. Vererb.*, **69**, 132 (1935).

# FORTHCOMING EVENTS

## Wednesday, September 19

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. Morris Muskat: "Our Unproduced Reserves—What are They?"

## Friday, September 21

TELEVISION SOCIETY, ENGINEERING GROUP (at C.E.A., 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. H. Page: "Slot Aerials".

## Saturday, September 22

BIOCHEMICAL SOCIETY (at the Rowett Research Institute, Bucksburn, Aberdeenshire), at 11 a.m.—Scientific Papers.

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# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ANALYST (with associateship of the R.I.C. and, preferably, experience in the analysis of foods and drugs) in the Department of the Public Analyst—The Registrar and Secretary, The University, Bristol (September 22).

ASSISTANT LECTURER (Grade III) and a LECTURER (Grade II) IN THE DEPARTMENT OF BOTANY—The Secretary, The University, Edmund Street, Birmingham 3 (September 22).

SENIOR LECTURER IN ADVANCED NON-FERROUS METALLURGY to Honours B.Sc. (metallurgy) standard—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 22).

DIRECTOR OF THE CITY ART GALLERY AND MUSEUM—The Town Clerk, Town Hall, Wakefield (September 24).

SCIENTIFIC TECHNOLOGIST (with a good general training in chemistry, preferably up to degree standard) in the Coal Survey Laboratory at Leeds—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/368 (September 24).

BIOCHEMIST (non-medical) IN THE PATHOLOGICAL DEPARTMENT—The Secretary, Nottingham No. 1 Hospital Management Committee, General Hospital, Nottingham (September 29).

LECTURER IN CHEMISTRY—The Principal, Norwood Technical College, West Norwood, London, S.E.27 (September 29).

LECTURER TO TEACH METALLURGY to engineering students preparing for the London University degree in engineering, and other examinations—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (September 29).

LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (September 29).

LECTURER or an ASSISTANT LECTURER IN THE ZOOLOGY DEPARTMENT, University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 29).

ASSISTANT PLANT PATHOLOGIST (with an honours degree in botany, and with special training in mycology)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (September 30).

EDUCATIONAL PSYCHOLOGIST (with Bachelor of Education degree or honours degree in Psychology)—The Secretary, Scottish Education Department, 14 Queen Street, Edinburgh 2 (September 30).

LECTURER (with a first- or second-class honours degree in mechanical engineering) IN THE DEPARTMENT OF APPLIED MECHANICS—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (September 30).

PROFESSOR OF ANATOMY—The Registrar, University College of South Wales, Cathays Park, Cardiff (September 30).

CHEMISTS (Experimental Officer grade) at a Ministry of Supply research establishment in Berkshire: (Ref. F.626/51A) with experience of gas analysis: (Ref. F.627/51A) experienced in factory development work; (Ref. F.628/51A) inorganic or physical chemist with knowledge of analytical procedure—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 8).

ENGINEERS I at a Ministry of Supply establishment in London: (Ref. C.509/51A) to be responsible for production, conversion and repair of aircraft, turbine engines and accessories, planning programmes and progressing; (Ref. C.510/51A) to be responsible for planning and progressing of specialized sub-contract supplies, vetting proposals for capital expenditure, and statistical analysis; (Ref. C.511/51A) to be responsible for planning and progressing the supply of engine accessories, including magnetos and ignition systems, also gun-turrets and tool kits—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 8).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in a science subject or in mathematics, or an equivalent qualification and, preferably, experience of fundamental research in chemistry) at the Norfolk Flax Establishment, King's Lynn—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4072/51 (October 11).

LECTURER IN ZOOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 13).

PHYSICS GRADUATE for a research appointment in Microwave Spectroscopy—The Secretary, University College, Southampton (October 15).

SCIENTIFIC ASSISTANT (with a university degree in electrical or mechanical engineering or physics) IN THE DEPARTMENT OF SCIENCE AND INDUSTRY—The Director, City Museum and Art Gallery, Birmingham 3 (October 15).

EXAMINERS (male, with a University degree in either physics or chemistry; some postgraduate research experience an advantage) IN THE GAS STANDARDS BRANCH, Ministry of Fuel and Power—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4073/51 (October 18).

FOREST ENTOMOLOGIST at the Forest Research Station, Alice Holt, Farnham, Surrey—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4070/51 (October 18).

LECTURER IN THE DEPARTMENT OF BOTANY (with special qualifications to lecture (through the medium of the Afrikaans language), guide and conduct research in cytogenetics, or systematic botany of lower plants)—The Registrar, University of Pretoria, Pretoria, South Africa (October 30).

RESEARCH ASSISTANT (with at least two years research experience and, preferably, a Ph.D.) IN THE DEPARTMENT OF CHEMISTRY, to carry out experimental work on Friedel-Crafts polymerization and related problems—Dr. P. H. Plesch, Chemistry Department, University College of North Staffordshire, Keele, Staffs (October 30).

RESEARCH PLANT BIOCHEMIST—The Head, Plant Physiological Institute, University of Pretoria, Pretoria, South Africa (October 30).

DIRECTOR (with a scientific training, preferably in zoology or anthropology) OF THE OTAGO MUSEUM, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURER IN INORGANIC CHEMISTRY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

HOLBROOK GASKELL CHAIR OF BOTANY—The Registrar, The University, Liverpool (November 17).

ENGINEER and SHIP SURVEYORS and NAUTICAL SURVEYORS in the Marine Survey Service of the Ministry of Transport—The Principal Establishment and Organization Officer, Ministry of Transport, Room 6029, Berkeley Square House, London, W.1 (December 1).

AGRICULTURAL ECONOMIST (with a degree in agriculture, horticulture or economics, and experience of investigational work), and an ASSISTANT AGRICULTURAL ECONOMIST (with a degree in agriculture, horticulture or economics)—The Registrar, Wye College, Wye, Ashford, Kent.

ASSISTANT CHIEF ENGINEER (Development) by the Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of a development team engaged on the construction and operation of prototype plants, involving both mechanical and chemical engineering—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ASSISTANT CHIEF ENGINEERS (Design), to take charge of teams of engineers and draughtsmen engaged on the design and detailing of special mechanical and chemical plant for manufacture on a production basis, and ENGINEERS (Design), to undertake the duties of project engineers, including the design of special plant and equipment and the layout required for efficient manufacturing processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

CHEMIST III at a Ministry of Supply establishment at Chislehurst, to be responsible for metallurgical analysis section and deputy to the Officer-in-Charge of laboratories—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.634/51A.

CHEMISTS (Experimental Officer grade) at Ministry of Supply research and development establishments mainly in the vicinity of Waltham Abbey, Sevenoaks, South-East London and Staffordshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.607/51A.

CHEMISTS (2, honours degree in chemistry essential, and textile experience an advantage) for research on problems relating to the dyeing and finishing of knitted products—The Secretary, Hosiery and Allied Trades Research Association, Thorneywood House, 4 First Avenue, Sherwood Rise, Nottingham.

CIRCUIT ENGINEER (with experience of radar pulse techniques) for work on digital electronic computing machines—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

DEVELOPMENT ENGINEERS by the Division of Atomic Energy (Production), Capenhurst, Chester, to assist in the construction and operation of prototype plants, involving mechanical and chemical engineering—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ELECTRICAL ENGINEER to design electrical equipment, including H. T. and L. T. switchgear, substations, and internal installations for large chemical factories, and an INSTRUMENT ENGINEER to undertake the design, provision and maintenance of instruments for the measurement of radioactivity and for the control and recording of pressures, temperatures and the flow of liquids and gases in pipes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

ELECTRICAL ENGINEERS and PHYSICISTS at a Ministry of Supply research and development establishment near London: (Ref. D.390/51A) ELECTRICAL ENGINEERS (Senior Scientific Officer grade) with special qualifications in radio communications and experience in the engineering of development prototypes; (Ref. A.245/51A) PHYSICIST (Senior Scientific Officer grade) with experience in electronic circuitry for research into the measurement of high speed transients; (Ref. A.246/51A) PHYSICIST (Senior Scientific Officer grade) with experience of optical and electronic techniques, and with an interest in fluid mechanics, for work on aerodynamics problems including wind tunnel investigations; (Ref. D.392/51A) ELECTRICAL ENGINEER or PHYSICIST (Scientific Officer grade) with interest in the application of electronic methods to optical instrumentation techniques; (Ref. D.391/51A) ELECTRICAL ENGINEER or PHYSICIST (Scientific Officer grade) for work on high speed electronic calculating machine—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

ENGINEERS and PHYSICISTS (Experimental Officer grade) at the Royal Aircraft Establishment, Farnborough, and an out-station in Bucks: (Ref. D.396/51A) capable of development of electronic tech-

niques and equipment, and special experience of miniaturization, or V.H.F. and U.H.F. radio and radar techniques an advantage; (Ref. D.397/51A) with experience in light mechanical and electrical mechanisms and equipment, and capable of research and development work in electronics, aircraft instrumentation, servo mechanisms, or analogue computing and automatic pilots—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Executive Engineer in the Public Works Department, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/4.

Graduate (with a knowledge of chemistry or physics up to a degree standard, and a good knowledge of French and/or German) in the Library and Information Department—The Director of Research, British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey.

Head of the Department of Radio and Musical Instrument Technology—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Hydrobiologist in the Sudan Government Fisheries Section, to work on freshwater hydrobiological problems in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Hydrobiologist 4/312'.

Junior Assistant Physicist—The Secretary, Royal Infirmary, Bradford.

Lecturer in Geology—The Registrar, The University, Nottingham.

Lecturer in Mathematics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Mechanical and Electrical Engineers (New Construction) for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Mechanical and Electrical Engineer, 4/320'.

Metallurgist (with a good university degree in metallurgy and a sound knowledge of physical chemistry) for a new important research in connexion with electrical sheet steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Physical Chemists (Scientific Officer grade) at Ministry of Supply experimental establishments mainly in the vicinity of Waltham Abbey, Sevenoaks and South-East London, for research and development work in the field of physical chemistry—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.603/51A.

Physicist or Physical Chemist (with a good honours degree and preferably an interest in the physical properties of materials) for work on fundamental problems associated with the hardening of Portland Cement—The Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

Professional Civil Engineers at the London office of the Crown Agents, in conjunction with the location, design and construction of a major bridge in East Africa—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27777.A.

Research Assistant (with a science degree and preferably some postgraduate research experience in chemistry) to take part in a programme of research in physical chemistry (reaction kinetics)—The Registrar, University College, Exeter.

Research and Development Chemists and Physicists by the Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of small teams of technical staff engaged on research and development work for a new factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

Research Officer (Forest Chemist) in the Forestry Department, Federation of Malaya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27106/45.

Science or Engineering Graduates to do research on either the flow of fluids through porous substances, or the theory of atomization of liquids—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

Scientific Assistant (Analyst) for the East African Agriculture and Forestry Research Organization—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27761.G.

Senior Electrical and Mechanical Engineer for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Senior Electrical and Mechanical Engineer, 4/320'.

Senior Lecturer (with high academic or professional qualifications, qualified to teach a main branch of chemistry to honours degree, and to direct research) in Chemistry—The Principal, Royal Technical College, Salford 5.

Senior Lecturer in Mathematics (to teach pure and applied mathematics up to general degree standard, and certain sections up to honours standard)—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Senior Lecturer in Physics—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

Senior Lecturer in Rayon Technology at Bradford Technical College—The Director of Education, Town Hall, Bradford.

Senior Lecturer, and an Assistant Lecturer, in Pharmaceutical Chemistry—The Secretary, Royal Technical College, Glasgow.

Senior Scientist, a Botanist, an Agronomist, and a Soil Scientist, in the Research Division of the Sudan Ministry of Agriculture, for work at a new station for agricultural research on rain grown crops—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Senior Scientist 4/316*a*', 'Botanist 4/316*b*', 'Agronomist 4/316*c*', or 'Soil Scientist 4/316*d*', as applicable.

Soil Survey Officer in the Department of Soil and Land-Use Survey, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/162.

Tutor (with an honours degree in science or mathematics, with physics as primary interest) in Berks, Bucks and Oxon—The Secretary, Services Education Committee, 7 Wellington Square, Oxford.

Wool Textile Research Council Scholarships for research on (*a*) woollen yarn manufacture, (*b*) cloth finishing, (*c*) for an investigation of the quantitative absorption of mordants—The Principal, Technical College, Queen Street South, Huddersfield.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Colonial Office. Colonial Research Studies, No. 4: Nandi Work and Culture. By G. W. B. Huntingford. Pp. iv+126. (London: H.M. Stationery Office, 1950.) 8*s.* 6*d.* net. [127

29th Report of Gresham's School Natural History Society. Pp. 32+2 plates. (Holt: Gresham's School, 1951.) 2*s.* 6*d.* [127

Empire Cotton Growing Corporation. Annual Report for the Year ending 31st March 1951. Pp. ii+22. (London: Empire Cotton Growing Corporation, 1951.) [127

A Statistical Survey of 56,122 Case Records of Employees in Royal Ordnance Factories examined by Ophthalmic Opticians, 1943–46. A Report by the Visual Welfare and Research Committee of the Association of Optical Practitioners. Compiled by S. Black. Pp. 40. (London: Association of Optical Practitioners, 1951.) 2*s.* 6*d.* [127

Broadcasting: Memorandum on the Report of the Broadcasting Committee, 1949. (Cmd. 8291.) Pp. 12. (London: H.M. Stationery Office, 1951.) 6*d.* net. [127

Colonial Office. The Colonial Territories (1950–51). (Cmd. 8243.) Pp. ix+184. (London: H.M. Stationery Office, 1951.) 4*s.* 6*d.* net. [177

General Register Office. Census 1951, England and Wales. Preliminary Report. Pp. xxiii+52. (London: H.M. Stationery Office, 1951.) 5*s.* net. [177

Alkali &c. Works Regulation Act, 1906, and Alkali &c. Works Orders 1928–1950. Eighty-seventh Annual Report on Alkali &c. Works covering the Year 1950. By the Chief Inspector. Pp. 56. (London: H.M. Stationery Office, 1951.) 1*s.* 6*d.* net. [177

British Standard 1736: 1951, Filling Ratios for Liquefiable Gases. Pp. 9. (London: British Standards Institution, 1951.) 2*s.* net. [177

Grassland Research Institute: Grassland Research Station. Experiments in Progress, No. 4, 1951. Pp. vii+104. (Stratford-on-Avon and Hurley: Grassland Research Institute, 1951.) 2*s.* 6*d.* [177

British Trust for Ornithology. Seventeenth Annual Report, 1950. Pp. 40. (Oxford: British Trust for Ornithology, 1951.) 1*s.* 6*d.* [177

British Museum (Natural History). Economic Series No. 14: Clothes Moths and House Moths; their Life-History, Habits and Control. Fifth edition. Pp. ii+28. (London: British Museum (Natural History), 1951.) 9*d.* [187

## Other Countries

East Africa High Commission: Filariasis Research Unit. Annual Report, 1950. Pp. ii+61. (Nairobi: East Africa High Commission, 1951.) [107

Bulletin of the American Museum of Natural History. Vol. 97, Article 1: Shoal-Water Geology and Environments, Eastern Andros Island, Bahamas. By Norman D. Newell, J. Keith Rigby, Arthur J. Whiteman and John S. Bradley. Pp. 30+8 plates. 75 cents. Vol. 97, Article 2: The Arachnid Order Solpugida in the United States. By Martin H. Muma. Pp. 31–142. 1.25 dollars. (New York: American Museum of Natural History, 1951.) [107

Rayon Revue. 1: Selection of articles from the 1947 volume of 'Rayon Revue'. Pp. 64. 2: Selection of articles from the 1948 volume of 'Rayon Revue'. Pp. 60. 3: Selection of articles from the 1949 volume of 'Rayon Revue'. Pp. 76. (Arnhem: International Rayon Trading Co., n.d.) [127

Field Museum of Natural History. Anthropological Series, Vol. 24, No. 2: The Medora Site, West Baton Rouge Parish, Louisiana. By George I. Quimby. (Publication 664.) Pp. 79–136. (Chicago: Chicago Natural History Museum, 1951.) 1.25 dollars. [127

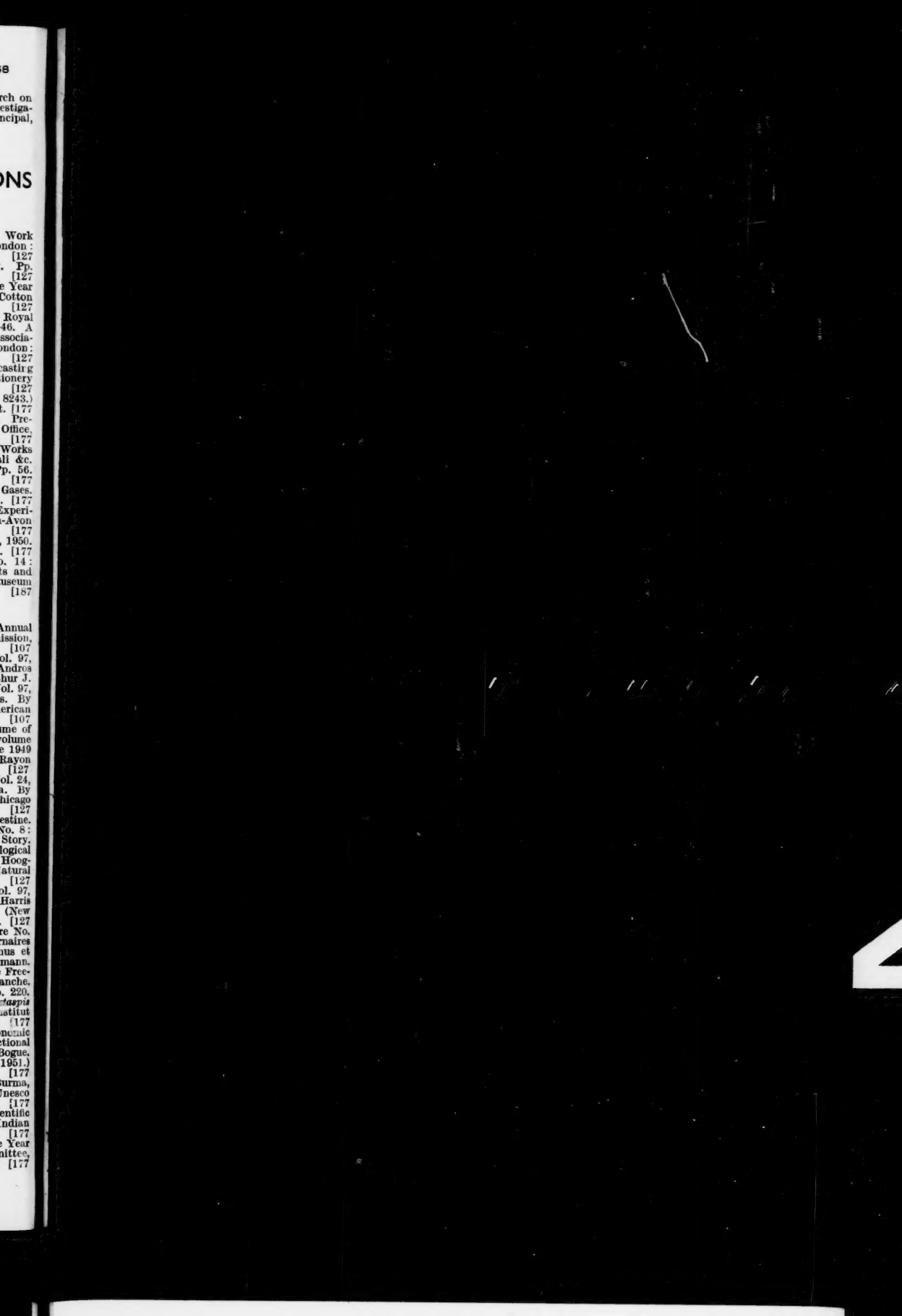
Fieldiana. Zoology, Vol. 31, No. 45: On the Clausiliidæ of Palestine. By Georg Haas. Pp. 479–502. 40 cents. Zoology, Vol. 32, No. 8: The Carotid Arteries in the Procyonidæ. By H. Elizabeth Story. Pp. 475–558. 1 dollar. Zoology, Vol. 33, No. 1: Philippine Zoological Expedition, 1946–1947; Narrative and Itinerary. By Harry Hoogstraal. Pp. 86+7 plates. 1.50 dollars. (Chicago: Chicago Natural History Museum, 1951.) [127

Bulletin of the American Museum of Natural History. Vol. 97, Article 3: The Ancestral Crocodilian *Protosuchus*. By Edwin Harris Colbert and Charles Craig Mook. Pp. 143–182+plates 9–16. (New York: American Museum of Natural History, 1951.) 75 cents. [127

Institut Royal des Sciences naturelles de Belgique. Mémoire No. 113: Les représentations de l'homme et des animaux quaternaires découvertes en Belgique; revision des documents déja connus et description de documents inédits. Par Prof. François Twiesselmann. Pp. 28+10 plates. Mémoires, Deuxième Série, Fasc. 37: The Free-living Marine Nemas of the Mediterranean, 1, The Bay of Villefranche. By Prof. Jacobus Hermanus Schuurmans Stekhoven, Jr. Pp. 220. Mémoires, Deuxième Série, Fasc. 38: Revision du genre *Atractaspis* A. Smith. Par Raymond Laurent. Pp. 50. (Bruxelles: Institut Royal des Sciences naturelles de Belgique, 1950–1951.) [177

Department of Commerce: Bureau of the Census. State Economic Areas: a Description of the Procedure used in making a Functional Grouping of the Counties of the United States. By Donald J. Bogue. Pp. iv+96. (Washington, D.C.: Government Printing Office, 1951.) 1 dollar. [177

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon). No. 4, July–December 1950. Pp. v+86. (Delhi: Unesco South Asia Science Co-operation Office, 1951.) [177

Indian Council of Medical Research. Report of the Scientific Advisory Board for the Year 1950. Pp. xiii+346. (New Delhi: Indian Council of Medical Research, 1951.) 1 rupee. [177

Annual Report of the Indian Central Jute Committee for the Year 1949–50. Pp. iv+212. (Calcutta: Indian Central Jute Committee, 1951.) [177